JRC Technical Notes

Case Study – Spain

Sustainable Agriculture and Soil Conservation (SoCo Project)

Javier Calatrava Leyva,
Gonzalo González Barberá, Víctor Castillo

EUR 24131 EN/1 - 2009

JRC
EUROPEAN COMMISSION

ipts
Institute for Prospective Technological Studies

ies
Institute for Environment and Sustainability

Case Study Spain

Sustainable Agriculture and Soil Conservation (SoCo Project)

The project 'Sustainable Agriculture and Soil Conservation (SoCo)' is a pilot project commissioned by the Directorate-General for Agriculture and Rural Development, in response to the request of the European Parliament (Administrative Arrangement AGRI-2007-336).

Authors:
Javier Calatrava Leyva[1], Gonzalo González Barberá, Víctor Castillo[2]

Editors:
Stephan Hubertus Gay, Monika Schmidt[3], Katrin Prager[4]

1 Universidad Politécnica de Cartagena (UPCT), Escuela Técnica Superior de Ingeniería Agronómica
2 Consejo Superior de Investigaciones Científicas (CEBAS-CSIC), Centro de Edafología y Biología Aplicada del Segura
3 European Commission, Joint Research Centre (JRC), Institute for Prospective Technological Studies (IPTS)
4 Humboldt-Universität Berlin, Faculty of Agriculture and Horticulture

The mission of the JRC-IPTS is to provide customer-driven support to the EU policy-making process by developing science-based responses to policy challenges that have both a socio-economic as well as a scientific/technological dimension.

European Commission
Joint Research Centre
Institute for Prospective Technological Studies

Contact information
Address: Edificio Expo. c/ Inca Garcilaso, 3. E-41092 Seville (Spain)
E-mail: jrc-ipts-secretariat@ec.europa.eu
Tel.: +34 954488318
Fax: +34 954488300

http://ipts.jrc.ec.europa.eu
http://www.jrc.ec.europa.eu

JRC 55635

EUR 24131 EN/1
ISBN 978-92-79-14628-2
ISSN 1018-5593
DOI 10.2791/35621

Luxembourg: Office for Official Publications of the European Communities

Printed in Spain

Preface

Agriculture occupies a substantial proportion of European land, and consequently plays an important role in maintaining natural resources and cultural landscapes, a precondition for other human activities in rural areas. Unsustainable farming practices and land use, including mismanaged intensification and land abandonment, have an adverse impact on natural resources. Having recognised the environmental challenges of agricultural land use, in 2007 the European Parliament requested the European Commission to carry out a pilot project on 'Sustainable Agriculture and Soil Conservation through simplified cultivation techniques' (SoCo). The project originated from close cooperation between the Directorate-General for Agriculture and Rural Development (DG AGRI) and the Joint Research Centre (JRC). The JRC's Institute for Prospective Technological Studies (IPTS) coordinated the study and implemented it in collaboration with the Institute for Environment and Sustainability (IES). The overall **objectives of the SoCo project** are:

(i) to improve the understanding of soil conservation practices in agriculture and their links with other environmental objectives;

(ii) to analyse how farmers can be encouraged, through appropriate policy measures, to adopt soil conservation practices; and

(iii) to make this information available to relevant stakeholders and policy makers EU-wide.

In order to reach a sufficiently detailed level of analysis and to respond to the diversity of European regions, a case study approach was applied. Ten case studies were carried out in Belgium, Bulgaria, the Czech Republic, Denmark, France, Germany, Greece, Italy, Spain and the United Kingdom between spring and summer 2008. The case studies cover:

- a screening of farming practices that address soil conservation processes (soil erosion, soil compaction, loss of soil organic matter, contamination, etc.); the extent of their application under the local agricultural and environmental conditions; their potential effect on soil conservation; and their economic aspects (in the context of overall farm management);
- an in-depth analysis of the design and implementation of agri-environmental measures under the rural development policy and other relevant policy measures or instruments for soil conservation;
- examination of the link with other related environmental objectives (quality of water, biodiversity and air, climate change adaptation and mitigation, etc.).

The results of the case studies were elaborated and fine-tuned through discussions at five stakeholder workshops (June to September 2008), which aimed to interrogate the case study findings in a broader geographical context. While the results of case studies are rooted in the specificities of a given locality, the combined approach allowed a series of broader conclusions to be drawn. The selection of case study areas was designed to capture differences in soil degradation processes, soil types, climatic conditions, farm structures and farming practices, institutional settings and policy priorities. A harmonised methodological approach was pursued in order to gather insights from a range of contrasting conditions over a geographically diverse area. The case studies were carried out by local experts to reflect the specificities of the selected case studies.

This Technical Note is part of a series of ten Technical Notes referring to the single case studies of the SoCo project. A summary of the findings of all ten case studies and the final conclusions of the SoCo project can be found in the **Final report on the project 'Sustainable Agriculture and Soil Conservation (SoCo)'**, a JRC Scientific and Technical Report (EUR 23820 EN – 2009). More information on the overall SoCo project can be found under http://soco.jrc.ec.europa.eu.

BE - Belgium	**West-Vlaanderen** (Flanders)
BG - Bulgaria	**Belozem** (Rakovski)
CZ - Czech Republic	**Svratka river basin** (South Moravia and Vysočina Highlands)
DE - Germany	**Uckermark** (Brandenburg)
DK - Denmark	**Bjerringbro and Hvorslev** (Viborg and Favrskov)
ES - Spain	**Guadalentín basin** (Murcia)
FR - France	**Midi-Pyrénées**
GR - Greece	**Rodópi** (Anatoliki Makedonia, Thraki)
IT - Italy	**Marche**
UK - United Kingdom	**Axe and Parrett catchments** (Somerset, Devon)

Table of content

List of tables

List of figures

Acronyms

AES	Agri-Environmental Scheme
C	Carbon

CAERM	Consejo de Agricultura Ecológica de la Región de Murcia (Council for Organic Agriculture of the Murcia Region)
CAP	Common Agricultural Policy
CARM	Comunidad Autónoma de la Región de Murcia (Regional Government of the Murcia Region)
CCAE	Confederación de Cooperativas Agrarias de España (Confederation of Agricultural Cooperatives of Spain)
CPO	Compulsory Purchase Order
e.g.	exempli gratia, for example
EU	European Union
GAEC	Good Agricultural and Environmental Conditions
GFP	Good Farming Practices
GMO	Genetically Modified Organism
ha	hectare
INE	Instituto Nacional de Estadística (National Institute for Statistical Data)
kg	kilogramme
LSU	livestock unit
MIMARM	Ministerio de Medio Ambiente y Medio Rural y Marino (Ministry of Environment and Rural and Marine Areas)
N	nitrogen
n/a	not applicable
NAPD	National Action Program to fight against Desertification
NGO	Non Governmental Organisation
OCA	Oficina Comarcal Agraria (District Agricultural Extension Office)
P	phosphorus
RDP	Rural Development Programme
RPOPIRM	Registro de Productores y Operadores de Producción Integrada de la Región de Murcia (Register of Producers and Operators of Integrated Production of the Murcia Region)
SMR	Statutory Management Requirements
SOM	Soil organic matter
UAA	Utilised Agriculture Area
UPA	Union de Pequeños Agricultores (Union of Small Farmers)
WFD	Water Framework Directive
WUA	Water Users' Association

1 Introduction to the case study area

The Guadalentín area was selected as a case study area because land degradation phenomena are very intense due to a combination of erosive farming practices and land abandonment in an area with semi-arid climatic conditions, vulnerable soil types and scarce but very intense rains. Several important soil degradation problems have been identified in the area. The case study region can be considered representative of Mediterranean areas in Spain, including areas where semi-arid dry-land farming predominates and areas with intensive horticulture. A further selection criterion was the availability of abundant data for the region as a result of several former research projects that have been conducted in the region during the last 20 years.

There is a lot of data available from previous research projects on the area, which can contribute to identify useful indicators for land degradation. In fact, the Guadalentín basin has been the subject of numerous research projects under different FPs of R+D of the EU: MEDALUS I, MEDALUS II and MEDALUS III, MEDACTION, DESERTLINKS, and the on-going DESIRE. These projects have studied a range of topics from basic processes of land degradation to the prediction of areas vulnerable to soil erosion as well as the role of socioeconomic processes. Although products are of diverse quality and usefulness, they configure one of the best bases for knowledge of soil degradation and restoration in Europe, particularly in the desertification-prone semiarid and sub humid areas.

1.1 Spatial and natural characteristics

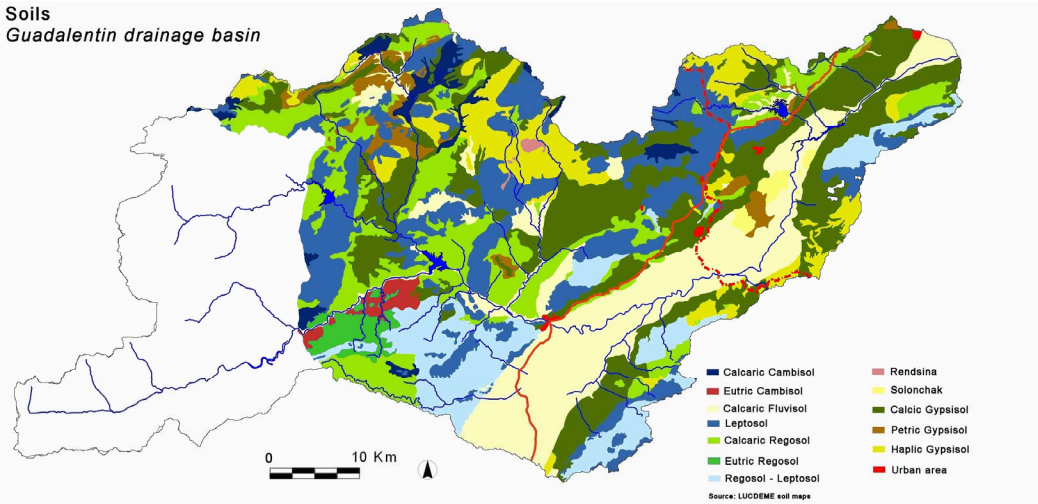
The Guadalentín area is located in the south of the Autonomous Community of the Murcia Region in South-East Spain. Its total land cover is 3,300 km^2, while its Utilised Agricultural Area (UAA) is 113,500 ha.

The upper section of the basin has a rather high drainage density in the headwater areas (mostly on Cretaceous and Jurassic limestones and dolomites or Paleozoic shales and phyllites), but also several meseta-like plains at altitudes of approximately 1,000 m. The middle section is characterised by an undulating landscape with long pediments and incised river terraces. The lower reach is characterised by a nearly flat valley bottom with a series of well-developed alluvial fans at the base of the sierras.

The climate is Mediterranean semiarid. The average annual precipitation ranges from 250-500 mm and the average yearly temperature ranges from 12 to 18 °C. There are frequent severe droughts. The mountainous areas are rural ones with low population density, while the plains have rapidly spreading urban areas.

Soils such as regosols and leptosols and soils rich in calcium carbonate are predominantly poorly developed. The valley bottom is dominated by calcaric fluvisols. These soils are characterised by an anthropized Ap horizon of about 40-50 cm. Practically all the calcaric fluvisols have been cultivated in the past or are presently cultivated. They are rich in clays (30-40 %) and silts (45-55 %). Carbon content is low (usually < 1.5 %) and C/N-ratio is 6-9. High salinity may be present as a result of both natural and anthropic processes. On the uplands the more common soils are leptosols and calcaric regosols. Leptosols have a very poorly developed A horizon (<10 cm) over bedrock. This A horizon also presents a variable range of carbon (< 2 % to > 5 %). Texture is low in clays (<15 %) and silt (20-35 %). Calcaric regosols are also poorly developed soils but where the A horizon is somewhat deeper (15-20 cm) and overlying over regolith. Carbon content is usually low (<1.5 %). In these soils clays are typically 15-20 % and silts 20-25 %.

Figure 1: Soils types in the Guadalentín basin



Source: Mapa Digital de Suelos de la Región de Murcia 1999. Consejería de Agricultura, Agua y Medio Ambiente, Murcia

1.2 Land use and farming

Non agricultural land accounts for approximately 99,000 hectares, which is mainly occupied with forest trees (35 %) and Mediterranean bushes (35 %).

In the Guadalentín there are six Special Protection Areas, as well as eight Special Areas of Conservation. These are located on mid-altitude ranges, totalling more than 60,000 ha and, although it covers basically mountain and highlands, it also covers large extensions of marginal agricultural areas of soil conservation concern.

There are around 13,500 farms with an average size of 16 hectares. According to data from the Spanish National Statistics Institute (INE, 1999), UAA is approximately 53 % of total land, i.e. approximately 113,000 hectares, with an average of 8.5 hectares per farm. 69 % of farms are smaller than 5 hectares and 89 % are smaller than 20 hectares. These account for 18 % of the total land and 28 % of UAA. On the other hand, a mere 2.5 % of farms are greater than 100 hectares, but account for 61 % of the total land and 45 % of UAA.

According to data from the Spanish National Statistics Institute (INE, 1999), only 5 % of farms employ fixed labour (a total of 3,000 persons), while 26 % hire temporary external labour (approximately 2,5 million days of labour). In 95 % of farms the owner works either physically or as a manager, while the wife or husband also works in the farm in 29 % of the farms and other family members participate in 24 % of farms. Data from our own and more recent unpublished survey sets the number of farms that hires temporary external labour in a 53 %, in a 79 % the number of farms that use family labour other than the farmer's, and in 93 % the number of farms where the owner works.

For around 42 % of farmers in the area agriculture their only activity and source of income, while for an additional 54 % agriculture is the main source of income, and for 4 % a secondary source of income (INE, 1999)[5].

Main agricultural uses are subsidised almonds and cereal crops and extensive pig production in the dry land mountainous areas and highly profitable intensive horticulture and greenhouses in the irrigated plains of the basin. Irrigated agriculture accounts for one third of UAA.

[5] INE (1999). Censo Agrario. Instituto Nacional de Estadística, Madrid.

94 % of the UAA is devoted to agricultural production while 6 % are permanent pastures. The part of the UAA used for agricultural production is divided as follows: 18 % for extensive crops (mostly cereals), 21 % for set-aside, 20 % for intensive horticulture, 8 % for citrus, 23 % for almond trees, 4 % for olive trees and 3 % for vineyards. Regarding livestock, 80 % of the 240,000 livestock units in the area correspond to pigs, followed by 6 % of beef cattle, 6 % of sheep, 5 % of poultry and 2 % of goat.

45 % of the UAA is irrigable, that is around 56,500 hectares, and 91 % of this area is effectively irrigated. According to the data from the Spanish National Statistics Institute (INE, 1999), 54 % of this area is drip-irrigated and 2 % is sprinkler-irrigated, although recent modernisation schemes for irrigated areas under the National Irrigated Areas Plan (2000-2008) have surely increased these figures. 70 % of the irrigated area is within irrigated districts and therefore farmers belong to Water User Associations.

1.3 Main soil degradation problems

Soil erosion by water is the main soil conservation problem in the Guadalentín and land degradation caused by water erosion can be found all over the basin. There is a high risk of soil erosion due to hill-slope cultivation, excessive or inadequate tillage techniques, irrigation with saline water, cultivation of natural areas and the subsequent removal of the vegetation cover, land abandonment and burning of stubbles, etc., all the above in a semi-arid climatic context with rains of high intensity and some rock types very susceptible to erosion. There are also severe soil salinisation problems in some parts of the basin, as well as a high risk of torrential flash floods. However, it has to be said that natural saline soils are common and highly valued ones from the point of view of biodiversity on the valley bottom and ephemeral stream channels.

Soil erosion by water is not a big problem in the irrigated areas of the valley, where the area is rather flat. In these areas, where the level of EU subsidies is very low and farm profitability is among the higher ones in Spain, intensive agriculture creates mainly problems of nitrate and pesticide pollution and soil salinisation. There is also a problem of decline in organic matter that is related with inadequate agricultural practices such as tilling and the removal of weeds. Agricultural policies, including agri-environmental schemes are not important in irrigated agriculture in this area in terms of the amount of payments received by farmers.

The problem of soil erosion is located in the rainfed agricultural areas in the highlands of the valley, where almonds, cereals, vineyards and olives are the main crops. These are less-favoured areas, with a severe problem of land fragmentation (70 % of farms: < 5 hectares), with low farm profitability, and in need of strong support to avoid further abandonment of agricultural land. These are the areas where agricultural policies are likely to have more impact.

Agricultural practices do not only cause soil erosion but even literal soil elimination. In fact most of the modern irrigated agriculture on the basin is based on heavy terracing on moderate slopes, and/or completely transforming topography thus eliminating very thin soils and planting directly on bedrock. This is possible because the types of lithologies in the area are very soft (e.g. marls) or moderately soft ones (e.g. phyllites) for modern machinery.

The three main sources of soil degradation problems are:

a) The abandonment of traditional soil conservation practices and structures on dry land agriculture (such as stone terraces). It has strong effects but in terms of area it is not as significant nowadays, as it has been the result of a severe rural depopulation that almost finished in the late 1970s. It does not only affect soil conservation but also results in a loss of landscape diversity and associated biodiversity. However, recent policies (agri-enviromental schemes and cross compliance rules in the context of the Single Payment Scheme) have increased the use of some soil conservation practices (such as tillage following contour lines) in non-irrigated agriculture.

b) The widespread conversion of land into irrigated agriculture during the last three decades has resulted in a severe transformation of the landscape, including a heavy alteration of topography and even the elimination of soil layer. Usually no conservation measures are applied in irrigated agriculture, resulting in heavy soil losses. This dynamic is also observed in the dry lands, although changes observed there are less drastic but also have severe effects. On irrigated agriculture this does not result in a loss of productivity at the moment as soil fertility is substituted by other inputs such as fertilisers, water, etc. However, there is also a long-term problem as the increasing water scarcity in the area and the resulting failure of agriculture enterprises may cause the abandonment of land that is heavily degraded and extremely difficult to be restored.

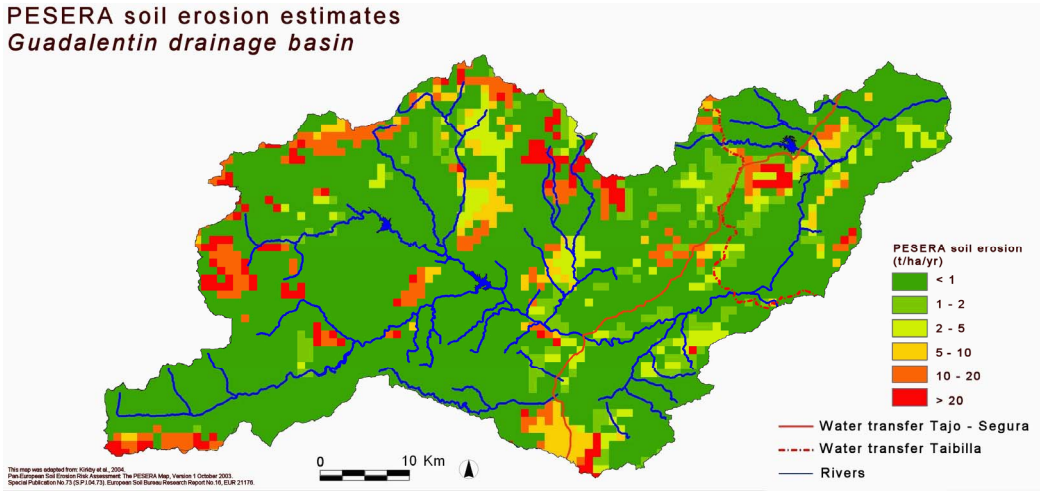
c) In the last ten years, there is an intense process of urbanisation far from the coast for residential tourism that creates extensive impervious surfaces and competes with agriculture for soil and water resources. It alters the patterns of runoff and strongly changes the attitudes of farmers towards agriculture as they expect possible highly profitable changes of use in their land. Therefore, it could further reduce the already low level of soil conservation measures adopted by farmers.

Local soil contamination has been important in other parts of the region where former mining activity was important, but is not a problem of special concern in the Guadalentín basin. Soil diffuse contamination can be more important because of the increasing density of pig farms; however there is not a good assessment of the problem.

Floods have been always a big threat in the Guadalentín basin, bringing about severe catastrophes such as the one in 1973. These events triggered a forest policy to enhance tree cover on the headwaters during the 1960s-1980s. This policy has produced extensive soil degradation due to the use of aggressive mechanical techniques (terracing) that increase the base levels of soil erosion on shrub lands. Landslides are uncommon in the region.

There are several sources of estimates of soil erosion risk in the Guadalentín basin. As an example, and for consistency at the European scale, Figure 2 shows the results application of the regional model PESERA.

Figure 2: Soil erosion rates in the Guadalentín basin



Source: Adapted from Kirkby, M.J., Jones, R.J.A., Irvine, B., Gobin, A, Govers, G., Cerdan, O., Van Rompaey, A.J.J., Le Bissonnais, Y., Daroussin, J., King, D., Montanarella, L., Grimm, M., Vieillefont, V., Puigdefabregas, J., Boer, M., Kosmas, C., Yassoglou, N., Tsara, M., Mantel, S., Van Lynden, G.J. and Huting, J. 2004. Pan-European Soil Erosion Risk Assessment: The PESERA Map, Version 1 October 2003. Special Publication No73 (SPI.04.73). European Soil Bureau Research Report No 16, EUR 21116

1.4 Land tenure system

96 % of farms in the basin belong to individual farmers, accounting for 73 % of UAA and 60 % of total land. The rest are mainly limited companies (15 % of total land and 20 % of UAA) and public entities (17 % of total land but only 0.03 % of UAA). In general, smaller farms are owned by residentals, while large dry land properties are owned by non-resident investors or limited companies. 94 % of farms are owned by farmers, while the rest are under different types of lease agreements.

Average price for selling non-irrigated agricultural land in the Guadalentín in 2007 was between 1,620 Euro/ha for pastures and 14,460 Euro/ha for almond trees, while land prices for irrigated land oscillated between 17,917 Euro/ha for almond trees and 73,986 Euro/ha for some citrus orchards. There are important pressures from the construction and tourist sector.

2 Methodology

This case study report has been elaborated using the information gathered from a series of semi-structured interviews that have been conducted with farmers and stakeholders that are experts either in soil conservation practices, policies or both. Relevant literature on the analysis of soil conservation practices and policy measures has also been consulted.

In total, four different questionnaires have been used as guidelines for the interviews. CEBAS-CSIC was responsible for the soil experts' Questionnaire (1). Universidad Politécnica de Cartagena (UPCT) has interviewed farmers in the case study area (Questionnaire 2), as well as administrative, governmental actors and civil society actors (Questionnaire 3 and 4).

Questionnaire 1 was designed to gather detailed information on farming practices, soil conservation measures and the links between certain practices and soil degradation types. In detail, an analysis was conducted covering the current soil conditions, their risk of degradation mainly caused by and related to farming practices, the effectiveness, costs, benefits, economic performance and practicability of soil conservation measures and farm management issues often remarked by farmers (e.g. restricted time spans for certain measures or difficulties handling crop residues when reduced tillage is applied). This questionnaire was developed as an excel spreadsheet and has been directly filled in by soil science and farming practices experts.

Questionnaire 2 was intended for farmers, farming cooperatives, cooperative associations and other relevant land users. It was designed to gather information on stakeholders' perception of soil degradation problems, farming practices being employed to conserve soils, experiences with and evaluation of soil conservation policies, impacts and motivation for the uptake of measures, different approaches to policy administration and implementation. A total of eight farmers operating different farm types across the case study area Guadalentín have been interviewed face-to-face and by telephone in May-July 2008 (Annex 1a). The participating farmers had been previously contacted for another survey on the issue (Calatrava and Gonzalez, 2008) and were very helpful in responding to the questionnaire.

A total of ten administrative and governmental actors (Questionnaire 3) were initially contacted, but only seven responded to our invitation. In two cases, the persons contacted in the first place argued that they were no experts and referred us to other experts in their departments. All of them provided helpful insights in the policy design as well as the policy implementation and evaluation process.

Regarding Questionnaire 4, a total of nine civil society stakeholders were initially contacted, but two of them (one farmers' union representative and one environmental NGO representative) refused to participate.

Four stakeholders were not able to answer all parts of the questionnaire, because they only participate in one stage of the policy process.

All interviews for Questionnaires 2, 3 and 4 have been conducted together by Javier Calatrava and Benito Pérez, a research assistant of UPCT working in a national project on the economics of soil erosion in South-eastern Spain. The average time spent in each interview was two hours and a half.

3 Perception of soil degradation in the case study area

3.1 Soil degradation problems

The soil experts and farmers identified a set of different degradation problems as important in the agricultural fields of Murcia. The relevance of the degradation, however, varies among crops. This is not only related to the way crops are managed but also to the specific place some crops have in the landscape.

Main problems identified are soil erosion by water, diffuse contamination, decline in organic matter and soil compaction (Table 1).

Table 1: Soil degradation problems in the case study area

Soil degradation issues	Soil erosion	Decline in organic matter	Diffuse soil contamination	Soil compac-tion	Salini-sation	Other issues
Severity	**5**	**3-4**	**2-3**	**2-3**	**4**	**Soil sealing due to urbanisation**

Note: The numbers indicate the *relevance of the main soil degradation issues (threats)* for the case study area, with the level being 5 = severe to 0 = not relevant. Ratings by soil experts from the case study.

Soil erosion and off-site effects

Soil erosion by water has been traditionally considered as the main problem in agriculture in South East Spain. According to the expert interviews, water erosion is highly relevant on rainfed (non-irrigated) tree crops and on rainfed cereal crops. The dominant rainfed tree crop is almond. Almond fields tend to occupy lands in the transition between ranges and plains, and also directly hillslopes on soft lithology ranges (schists, marls). The expansion of almonds on these hillslopes has been favoured by the introduction of heavy machinery on regional agriculture from 1950s onwards. In general, the management of almond crops is based on intensive tillage to improve water infiltration to tree's root system. Thus, the combination between landscape position and agricultural practices do the almond crops highly vulnerable to water erosion. Additionally, the crown cover of almond trees is loose and it has only leaves from February to September, giving very low protection to the soil in general. This is especially relevant in the heavy rainstorms of autumn. In these systems water erosion is reinforced by redistribution of material by the tillage itself (tillage erosion) and in the case study area it has been estimated a soil loss of > 25 t ha^{-1} y^{-1} (van Wesemael et al., 2006). Simulation studies suggest that combined tillage and water erosion can completely modify soil basic parameters like rock fragment distribution on a decadal scale time window (Govers et al., 2006).

Barley is the dominant cereal crop and is also identified by soil experts as highly vulnerable to water erosion. Although barley is not cultivated on hillslopes like almond trees it is highly represented on marly areas, a material of high erodibility. Barley fields are nearly completely bare from May-June to January, therefore giving very low protection to the soil in the critical period of autumn. When the management leaves no fallow lapse the remaining protection given by barley residuals is eliminated by conventional tillage (López et al., 2003). When

compared along a series of land uses on the Region of Murcia on experimental plots barley shows the highest losses of nutrients by soil erosion (Alías et al., 1997).

Thus, the two main rainfed crops are considered highly vulnerable to water erosion, indicating that the experts believe that large tracts of the region are threatened. In the case study area, using the replacement cost method, the economic cost of erosion for these crops is estimated to range from 5 € ha^{-1} to 50 € ha^{-1} for slopes of 5-10 and 30-50 % respectively (Hein, 2007).

Rainfed systems have partly suffered from land abandonment because of their scarce profitability. The land abandonment can generate even more problems of soil erosion. In fact, in other catchments of South East Spain it has been measured that erosion rates partly increase on abandoned fields when compared to cultivated fields because of soil crust formation and reduced storage capacity. Abandoned fields on channel heads or channel walls are at high risk of suffering from high erosion (Lesschen et al., 2007). Piping is also a severe erosion feature that appears on abandoned fields on the marls (Romero-Díaz et al., 2007). Marl is an abundant lithology within the case study area.

At a second level of risk, classified as medium vulnerability, there is a set of crops that can be basically defined as irrigated trees. The main crop in the Guadalentín is citrus trees, principally lemon. Grapes for table are also relevant in the area and some experts consider this crop at a high vulnerability while others classify them as a medium vulnerability. In any case, differences in vulnerability of these crops in respect of rainfed (non irrigated crops) arise of two basic reasons. On the one hand, they tend to appear in less abrupt areas of the landscape although there are numerous examples on areas of high slope gradient. On the other hand, crown cover is much higher, especially on citrus crops that are perennial. However, the modern agrarian practices favour the impact of water erosion. Modern practices are related to heavy transformation and management of fields. During the 20th century there was a 4-5-fold increase on irrigated land. Consequently, many former rainfed fields, shrublands and pastures were transformed into irrigated land. It was carried out using massively heavy machinery to (i) level the terrain, (ii) remove stones, rocks or the very common petrocalcic horizon. On the other hand, many of these transformations removed and/or did not build soil conservation structures as drip irrigation let to irrigate on non-flat reliefs without losing the water. As a consequence soils were severely disturbed losing soil quality (carbon content, aggregate stability, infiltration capacity and so on) and left unprotected to water erosion.

Finally, intensive vegetable crops (cauliflower, broccoli, lettuces, etc.) are considered by most of the experts as crops of a low vulnerability. In this case, crops are basically located on flat areas. However, the transformation of other land uses to this one is frequently associated to a high impact on the soil. Also, on marl soils (a common setting from this kind of crops in the case-study area) irrigation with fresh water can promote piping by removing carbonates and facilitating the piping process (García Ruiz et al., 2007)

Unfortunately irrigated lands have not been studied like rainfed systems and there is no empirical quantitative information. Thus, much of the above comments are based on qualitative assessment (Martínez-Fernández and Esteve, 2005).

Water erosion is tightly associated to off-site effects and damages. Therefore, it is logical that experts' opinion ranking of both threats correlate quite well. The expansion of almond crops in the area have been shown associated to the expansion of gullies and bank gully activity (Oostwoud Wijdenes et al., 2000). This is a good predictor of strong off-site effects along the watershed.

It is interesting to point out that paradoxically, some crops of a low vulnerability to soil erosion were ranked as a medium vulnerability to off-site damage. This is especially notorious for intensive vegetable crops (tomato, cauliflower, lettuce, broccoli, artichoke, melon). This is probably related with the fact that although most of these crops are located in areas of low

risk (i.e. very flat terrain) they are managed so intensively and usually they are so large and monotonous with no barriers that occasional very heavy storms can mobilize runoff and sediments that can damage infrastructures. Furthermore, these crops are usually established in areas more densely inhabited and with highly developed infrastructure. Therefore, the damage with the same input of runoff and/or sediment may be economically more damaging.

Diffuse contamination

The second problem that has been considered is diffuse contamination although not all crops are affected. All the crops under irrigation are considered as highly vulnerable to generate diffuse contamination. The experts' opinion therefore is a clear statement that fertiliser and pesticide use in the intensive crops are excessive and able to generate problems on the soil, ephemeral water courses and aquifers.

In the watershed of "El Albujón", just on the south-eastern border of the case study area, it is estimated that >55 % of nitrate on the superficial waters is of agricultural origin (García-Pintado et al., 2007). In south-central Spain it has been found that there is a positive correlation between nitrate concentration in the river and the proportion of agricultural land uses (Lícer et al., 2007). For aquifers it is estimated that most of the nitrate comes from agricultural activities. The more intensive a crop is the larger is its impact. Thus in Seville province (SW Spain) it has been found that intensive crops (cotton and potato in that case) are responsible for highest levels of nitrate on the aquifer (González-Vázquez et al., 2005).

On the other extreme, diffuse contamination is not a concern in the rainfed agriculture. It is another example of the duality of regional agriculture.

Decline in soil organic matter and carbon balance

Although a decline in soil organic matter is usually ranked to have a medium vulnerability level it has a much more extended impact than diffuse contamination. In fact, most of the experts considered that all the crops suffer this problem, and also most of them ranked it as a medium vulnerability.

Decline in soil organic matter can originate from different processes. The high vulnerability of rainfed crops and some irrigated crops to soil erosion is associated to the loss of soil superficial layers richer in organic matter. This is especially relevant in a region where soils have in general low levels of organic matter.

However, the loss of soil carbon in olive groves in the Region of Murcia can be also related to the agricultural practices (Martínez-Mena et al., 2008) as intensive tilling and elimination of weeds promote the decline of organic matter. On rainfed crops farmers till abundantly, especially on almond crops in order to theoretically facilitate water infiltration to tree roots and eliminate any competitor weed. In this semiarid climate rainfall input is very low. On irrigated land, especially on vegetables, tilling is intensive in order to prepare soil for rows that structure crops. This frequent tilling facilitates aeration and the loss of organic matter.

Interestingly experts did not point out the existence of a negative carbon balance except for almond crops, and thought of a low vulnerability. Apparently, if a decline in organic matter is recognised as an important and extended issue, a negative carbon balance may also be a relevant issue. The lack of correlation between these assessments is maybe related to the lack of empirical data of carbon balances on the crops in the region, that are just now beginning to be known in some representative examples.

Soil compaction

Soil compaction is considered as an issue for all the crops reported in the study area. Most of the opinions rank it as a low or medium vulnerability with no clear way to group crops in one or another group. However, there is no empirical quantitative information. Experiments on

south Spain suggest that soil compaction caused by machinery do alter the water retention curve in a negative way for plants (Fernández-Gálvez and Barahona, 2005).

Salinisation

Salinisation is another of the traditional risks associated to agriculture in the area. From the experts assessment it is clear that this threat is concentrated on the vegetable crops in the bottom of the Guadalentín valley.

Salinisation arises from the quality of water used and the way it is used. Most of the aquifers in the case study have been severely overexploited, especially on the main valley. In this sector water table depths have increased hundreds of meters from the 1950s. This has led to salinisation through the movement of water of deeper aquifers which are naturally saline. On the other hand, drip irrigation is nowadays the most common technique for irrigation. Drip irrigation makes the use of the water much more efficient but however tends to increase salt concentration. On sectors of South East Spain they have occurred drastic decrease in soil quality and productivity due to salinisation process (Pérez-Sirvent et al., 2003).

It is important to point out that the case study area is rich in naturally saline soils. Miocenic marls are abundant and usually rich in salts while Keuper marls are less common but extremely rich in salts. Gypsum outcrops are frequent. The valley bottom of the Guadalentín has semi-endorheic characteristics that under semiarid climatic conditions lead to a concentration of salts transported by runoff. The central area of the valley (close to Alhama de Murcia and Totana towns) was a water discharge area of the aquifer previously to overexploitation. Because of the high potential evapotranspiration the discharge was not as open water masses but as evaporation from soils and halophytic communities. This form of discharge contributes to concentrate salts in the soils.

3.2 Trends in soil degradation during the last ten years and consequences

Judging on the ground of experts' assessment and interviews to farmers trends in soil degradation have slightly improved in the last decade trough the adoption of some measures and programmes.

The interviewed farmers have adopted mandatory schemes because of their compulsory character. On the other hand, about half of the farmers have adopted measures like conservation tillage as they perceive practices as effective.

4 Farming practices and soil conservation measures

4.1 Farming practices and their effects on soil

In the case study there are two very different types of agriculture that co-exist. On the one hand, the rainfed agriculture, that is severely limited by the semiarid climatic conditions and concentrated on almond and barley. It is extended on the hilly areas, the transition between ranges and valleys and in the high plains outside the main valley of the Guadalentín. On the other hand, it is the highly intensive and profitable irrigated agriculture concentrated in the valley and growing citrus, table grapes and vegetables.

Table 2 summarises the most representative crops of these two systems and their impacts on soil that have previously been commented in section 3.

Table 2: Typical cropping systems, their characteristics and the estimation of impacts of soil degradation problems in the case study Guadalentín

Crop	Almond – ware	Broccoli – ware	Barley, spring – grain	Grape, table – fruit, first period	Citrus fruit, other – fruit, first period	Tomato – fruit	Lettuce – ware	Olive, oil – fruit, first period
Production orientation	conventional	conventional	conventional	conventional	conventional	conventional with zero tillage	conventional	conventional
Farm type	arable farm	arable farm	arable farm	arable farm	arable farm	arable farm	arable farm	arable farm
Tillage type	ploughing	ploughing	ploughing	ploughing	ploughing	zero tillage	ploughing	ploughing
Irrigation type	no irrigation	drip irrigation	no irrigation	drip irrigation	drip irrigation	drip irrigation	drip irrigation	no irrigation
Soil quality class[a]	1	3	2	1	3			1
Soil degradation problem	vulnerability							
Soil erosion water	high	low	high	high	medium	low	low	high
Decline in organic matter	medium	medium	medium	low	medium	medium	medium	medium
Negative carbon balance	medium							
Diffuse contamination	low	high		high	high	high	high	high
Compaction	low	low	medium	medium	medium	low	low	low
Salinisation	low	high				high	high	
Decrease of water-retention capacity	high	low	high	medium	high	low	low	medium
Off-site damages	high	medium	high	medium	medium	medium	medium	high

a: There are three soil quality classes in the case study: class 1 means Calcaric regosol on metaphorphic material, very shallow soils with low organic matter content, sensitive to dispersion, crust formation and soil erosion (poor quality); class 2 means Calcaric regosol on metamorphic material; low organic matter sensitive to soil erosion (poor quality); class 3 means Calcaric fluvisol; alluvial planes and bottom valleys with deeper soil profiles and better water availability, many of these soils have salinisation problems (moderate - good quality)

Note: in addition to these results further statements to typical cropping systems were given in the framework of questionnaire 2

Source: own presentation based on expert assessment

Farming practices that cause soil degradation

Based on the opinion of experts, interviews to farmers and published literature the farming practices that cause soil degradation can be grouped into different sets.

a) Tilling practices

Ploughing as a conventional tillage is used in most of the crops for common and specific purposes. In tree crops (basically almonds) it is used as a system for increasing soil infiltration and removing weeds. In annual crops (barley, vegetables, etc) it is used for seedbed preparation.

The region is characterised by a relatively rugged landscape with an abundance of rainfed crops on ranges and the transition from ranges to plains and a diversity of soils originated over materials of high erodibility. Particularly abundant are marls that easily form piping, gullies and badlands. Some forms of ploughing like ploughing following a slope gradient are specially damaging the soil. In intensive agriculture in the main valley soil preparation on annual vegetable crops is usually especially intense, and soil is not only ploughed but smashed forming a fine layer easy to be modelled for rows, plantation, installation of pipes for drip irrigation, etc.

So intense preparation and management and the large duration of bare soil and/or low crop cover and the high intensity of rainfall leads to very high risks of soil erosion. However, there are differences in the rate of soil erosion depending on the way of ploughing. On slates, simulation models suggest that conversion into almond tree crop can lead to peak increase of soil erosion lasting several decades if chisel tillage is applied while mouldboard tillage will have less severe impact (Govers et al., 2006). Chisel tillage is the common method used in this area.

b) Soil compaction

The intensification of agriculture has resulted in the massive use of machinery especially in the most intensive crops like vegetables. Although soil compaction is not considered by the experts as of maximum concern in the area it has to be noted that there exists an indirect link between soil compaction and water erosion and that there are detrimental effects on plant water economy (Fernández-Gálvez and Barahona, 2005). In fact, soil compaction by the use of heavy machinery on intensive agriculture increases even more the intensity of ploughing at the beginning of the plantation time.

c) Organic matter content

Conventional tilling causes a decrease in soil organic content in this kind of agrosystem (Alvaro-Fuentes et al., 2008). Soils are low in carbon content because the semiarid climate reduces biological productivity. Tillage practices promote aeration and destruction of soil aggregates, thus facilitating organic matter reduction while the increased water erosion facilitates organic matter exportation out of the agrosystem (Martínez-Mena et al., 2008).

d) Diffuse contamination

Diffuse contamination has arisen as one of the main soil threats in the areas of the case study where intensive agriculture is established. The practices that lead to this soil degradation problem are the excess application of fertilisers and pesticides. On similar parts of Spain it has been found that crop yield is more related to drought than to N availability by artificial fertilisation (Villar-Mir et al., 2002) pointing out that fertilisation is not being wisely applied.

e) Salinisation

Clearly the problem of soil salinisation is related to the use of bad quality waters coming from oversalted overexploited aquifers. However, the reuse of sewage waters is also important. When these waters have no tertiary treatment they can decisively contribute to soil salinisation (Pérez-Sirvent et al., 2003).

Farming practices that prevent soil degradation

a) Soil conservation structures

Mediterranean agriculture has been characterised by the extended construction and maintenance of soil conservation structures (SCS). Soil conservation structures (walls, banks, etc) not only reduce significantly the risk of erosion on the concerned agricultural field but highly reduce off-site impacts facilitating the existence of sinks for runoff and sediment coming from channels, hillslopes or other agricultural fields. Therefore, a dense network of SCS acts diminishing landscape connectivity to water and sediment fluxes having a very positive effect on the reduction of erosion risk (Bellin et al., in press). At the case of the study area the importance of SCS has diminished significantly in the last 50 years. Many of the structures on rainfed fields are not adequately maintained or simply are abandoned. This is because maintaining these structures is costly. In addition, SCS adapt badly to modern agriculture relying on machinery, irrigation infrastructures, etc. The large transformation of agriculture into an intensive and irrigated model has eliminated many of the SCS or when formerly non cultivated land has been ploughed and planted, these structures simply have not been built

b) Control of water erosion

This issue is probably dominant where more efforts have been concentrated in the area as it has been traditionally considered the most important threat to soils. The main farming practices adopted are contour tillage and the restriction of row crops on steep slopes as well as reduced tillage. Nevertheless, the rate of adoption by farmers is not high and experts evaluate in less than 20 % the number of farmers using them.

Reduced tillage can significantly reduce erosion rates (Milgroom et al., 2007). No-tillage seems to provide a buffering of crop productivity in the driest years (Gómez et al., 1999; Ordoñez-Fernández et al., 2007)

Farming practices used in the long term for preventing and combating land degradation focus also very much on addressing soil erosion. Important soil conservation structures are ditches, bench terraces and retention ponds. Experts estimate that 20-40 % of the farmers implement such structures on their fields. However, in traditional agriculture the rate of implementation of this kind of structures was much higher. The density of these structures is well related to the decrease of landscape connectivity and therefore to the reduction of on-site erosion and off-site effects (Bellin et al., in press)

Other kinds of farming practices used for reducing soil erosion like undersown crops, grass strips or intercrops are not used in the case study area. It is clear that the application of such farming practices would be hardly implemented by farmers in a region where the water deficit is considered as the main problem in agriculture. Farmers consider that these practices generate competition for water and thus risk profits. Nevertheless, there is some research at the present in order to assess the effective competition of cover crops with typical rainfed crops like almonds.

c) Control of diffuse pollution

Diffuse contamination has arisen as one of the main soil threats in the case study in the areas which are intensively farmed. The practices that lead to this problem are the excess application of fertilisers and pesticides. Therefore, a reduction of the application rates is a viable alternative.

The application of liquid manures to crops is common in the region where pig breeding is an important resource. Therefore restricting liquid manure application is one of the main farming practices used to control soil degradation. Similarly the restriction of application of manure and N and P fertilisers is used. Nevertheless, when comparing the application of farming practices to prevent water erosion to the proportion of farmers effectively implementing these practices this is considered quite low, less than 20 %.

d) Decline of organic matter

The use of exogenous organic matter for improving soil quality is a farming practice that is becoming more popular between farmers and is estimated to be applied by 30 % of them. No tillage and direct drilling techniques have positive effects on organic matter and nutrient content. Alvaro-Fuentes et al. (2008) have tested the effect of no tillage (NT), reduce tillage (RT) subsoiling tillage (ST) and conventional tillage (CT) on soil organic carbon. They demonstrate that soil carbon in general increases in the sequence NT > RT > ST > CT. Ordoñez-Fernández et al. (2007) also have demonstrated this effect as well as an increase on N an P content of the soil on a long term study in a wheat-sunflower-legume rotation comparing conventional tillage to direct drilling. In this case, on average there are no differences in crop productivity between both systems but when only dry years are studied direct drilling performed better.

e) Salinisation

While no short-term control measures were cited for salinisation in the long term more than half of the farmers are estimated to prevent it controlling the quality of water and the management of irrigation. Nevertheless, the shortage of water resources for irrigation is frequently in the area and will become more frequently. The sources of water for irrigation are local superficial resources from the own Guadalentín river, water imported from Tagus river in central Spain, the (over)exploitation of aquifer and, increasingly, desalinated water from the sea or salinised wells. Droughts in SE and in the headwaters of Tagus tend to be correlated and therefore it is common that very little or no water is available for irrigation from these resources on some years. When this happens, farmers turn on worse quality waters and therefore prevention measures may have a limited effect.

4.2 Suitable soil conservation measures

An overview of expert evaluations of cropping/tillage soil conservation measures on soil degradation problems in the case study area independent of crop types is shown in Table 3. Experts also used the opinion of farmers to critically assess the suitability of the conservation measures.

Short-term measures

Reduced tillage and contour tillage are the main soil conservation measures that farmers apply in the area related to tillage. The degree of application is relatively low at the judgement of experts as referred above. However, when farmers are interviewed the practical totality declares doing contour tillage and half of them an intermediate between conventional tillage and reduced tillage (basically no chisel or similar tools). Probably, experts have a worse perception of reality and farmers project a better image about themselves. A similar effect can be observed when farmers' opinion about the state of soil conservation on their properties is better than the state of soil conservation in the case study area as a whole. No tillage seems a very minority option and probably is not very much suitable in the region.

Interestingly experts think that both measures mitigate the problem of water erosion but are not necessarily *highly* effective, i.e. it will not stop erosion altogether but only mitigate it (only suppressing crops and reverting to semi-natural vegetation in the long-term could be highly effective). The same can be said about the decline of organic matter. There are several reasons for it. Basically, frequent tillage and pro-slope-gradient tillage aggravate the water erosion and the decline of organic matter but the simple combination of some tillage practices, the low cultivation of cover crops and/or long times of bare soil, dry climate, heavy rains and erodible lithologies accomplish the case study area very susceptible to water erosion when common agricultural practices are applied. That is to say, some kind of "base-line" erosion could be difficult to be eliminated. Nevertheless, contour tillage is considered to be highly effective in the prevention of off-site damages.

In this sense, it seems that these short-term measures are absolutely necessary to control the threat of water erosion and the associated loss of organic matter (exported with fine sediments) but they are not sufficient by themselves to adequately tackle the problem.

The restriction of row crops on steep slopes is considered to be highly effective for the prevention of water erosion and off-site damages. Although in Questionnaire 1 it is included as a short-term measure in the context of the case study area it has to be understood as a long-term one. In fact it is more related to the abandonment of some tracts of land that to temporal restrictions.

In the case study area there is no application of measures like intercrops, undersown crops or grass strips. As explained before intense competition for scarce water resources are important to understand why farmers do not implement this kind of measures as it is clearly against a very much settled agricultural culture. One problem concerning the possible application of this kind of measures is the lack of empirical knowledge about the effects on production of the main crop. The opinion of experts is that the intercrops and undersown crops would mitigate the problem of water erosion and off-site damage but they would not be highly effective. On the contrary, grass strips are considered by experts as a measure that would be highly effective. Martínez-Raya et al. (2006) tested the use of vegetated strips using local shrubs (thyme, usually < 30 cm high) and crops (barley, lentils) in almond crops in the Granada province. All of the vegetated strips significantly reduce the sediment and runoff in respect of control plots. The most successful strip was the thyme one reducing soil and runoff by 97 and 91 % respectively. These results point out the potentiality of this system to reduce soil erosion.

In respect of the control of diffuse contamination the experts consider that the restriction on the maximum amount of N and P fertilisers are highly effective measures while the control of manures, solid or liquid, is effective but not so much. It is clear that this is related with the nutrient richness of each type.

Table 3: Effects of cropping/tillage soil conservation measures on soil degradation problems

	Soil degradation problem									
Measures	soil erosion water	soil erosion wind	decline in organic matter	negative carbon balance	diffuse contami-nation	compaction	salinisation	acidification	decrease of water reten-tion capacity	Off-site damage
Reduced tillage	1		1			1				1
Contour tillage	2		0						1	2
Restriction of row crops on steep slopes	2		1			0				2
Restrictions on the max. amount of (liquid) manure application					1					1
Restrictions on the max. amount of n-fertilisation					2					2
Restrictions on the max. amount of p-fertilisation					2					2

Legend: Own presentation. The numbers indicate *the general effects of soil conservation measures on soil threats in the case study*, examined in questionnaire 1 with the following units: 2 = farming practice highly mitigates the threat, 1 = farming practice mitigates the threat, 0 = farming practice has no effect on threat, ne = depending on other variables the farming practice mitigates or increases the threat. The grey marked cells are not relevant because this measure has no relationship to the threat.

Table 4: Effects of long term soil conservation measures on soil degradation problems

	Soil degradation problem									
Measures	soil erosion water	soil erosion wind	decline in organic matter	negative carbon balance	diffuse contami-nation	compaction	salinisation	acidification	decrease of water reten-tion capacity	Off-site damage
Change of crop rotation	1		1			1			1	1
Use of organic soil improvers/exogenous organic matter	1		2			1				2
Irrigation management to mitigate salinisation							2			
Control of irrigation water/use of appropriate water quality							2			
Retention ponds	0				1					2
Hillside ditches	0				0					
Bench terraces	2				2					2

Legend: Own presentation. The numbers indicate *the general effects of soil conservation measures on soil threats in the case study*, examined in questionnaire 1 with the following units: 2 = farming practice highly mitigates the threat, 1 = farming practice mitigates the threat, 0 = farming practice has no effect on threat. The grey marked cells are not relevant because this measure has no relationship to the threat.

Long term measures

The effects of long term measures on the identified soil degradation problems were evaluated by soil experts. These considerations are presented in Table 4.

The experts consider that bench terraces are highly effective measures to combat water erosion and off-site damages. They also consider retention ponds as a highly effective measure to reduce off-site damages. Therefore they point out that for combating water erosion on the area long-term measures are the most necessary. Interviews to farmers show that more than 75 % of them agree to conserve terraces and benches with vegetation in order to favour soil conservation.

The addition of organic matter to improve the soil is considered by experts as a highly effective measure but only a minority of farmers is really implementing this. Most of the available organic matter comes from three sources: (i) pig manure; (ii) compost from urban wastes; (iii) sludge from sewage plant. The largest urban waste treatment plant in the region uses a system of co-composting of (ii) and (iii) together in order to facilitate the treatment of sludge. Obviously, these three sources of organic matter present problems of application as they can damage crops and/or add contaminants, especially heavy metals, to the soil. In the highly basic soils of the region heavy metals tend to stay not mobile in the soil and are not available to plants but it is still a concern. On the other hand, as most of the compost production is concentrated in only 1-2 large plants the cost of transport can be proportionally expensive (in comparison to base price without transport).

As a result the crops are not receiving adequate inputs of available organic matter and the costly produced compost turns into a new waste as there is not enough demand. A key point here seems to be the lack of information and technical training of farmers to adequately use this source of organic matter in a wise and controlled form. Therefore, farmers rely much more on pig manure as it is a product closer to their traditional knowledge.

The experts support the application of the control of water quality and irrigation management to prevent salinisation. This measure is probably the most problematic because of the acute shortage of water resources - farmers use any kind of water they have available when drought years reduce the available high quality resources. There is some possibility in improving the quality of the treatment of sewage waters and desalinised water from salinised wells, but both options are expensive.

5 Evaluation of soil conservation measures

In the case study Guadalentín only a part of the soil conservation measures reviewed in this study have been implemented. In some cases not implemented measures are simply not relevant to the local conditions (e.g. liming). In other cases the local farming culture and environmental conditions make the adoption of these soil conservation measures (like intercrops or undersown crops) difficult. In any case, even for the soil conservation measures that are used in the region, the farmers do not use them as frequently as desirable.

5.1 Cropping/tillage measures

In the Guadalentín region, the following cropping/tillage measures are applied by farmers:

- reduced tillage
- restrictions on the max. amount of (liquid) manure application
- restrictions of manure application to a certain time period
- restrictions on the max. amount of N and P fertilisation

The following cropping/tillage measures are not used but have possibility of being applied:

- intercrops
- undersown crops
- no tillage/ direct drilling

Reduced tillage or less aggressive forms of conventional tillage seem to be the most applied measures by farmers and they are the measures farmers and experts consider most suitable. The problems to their extension in the case study area is related to the traditional conception on farmers' culture that intense tilling is necessary in rainfed agriculture to increase water infiltration and hence crop productivity. Long term studies on the almond agrosystems show, on the contrary, that intense tillage can long-term reduce the capacity of supplying water resources to the plant. On the other hand, experts consider that the cost-effectiveness of this measure is high in order to prevent soil erosion, off-site effects and decline in organic matter. Therefore, the extension of this measure can be relatively problematic (breaking traditional beliefs and knowledge) but returning high environmental and economic profits. Nevertheless, the younger and better educated farmers are more prone to adopt these techniques.

Intercrops, undersown crops and no tillage are cropping measures that are not practically used in the case study area because of confrontation with traditional knowledge and beliefs of reducing water competition to the focal crop. However, recent results on similar agro-ecosystems show very promising results based on vegetated bands using local species adapted to semiarid climate (Martínez-Raya et al., 2006). Because an estimation of costs is lacking it is difficult to evaluate the opinion of farmers. In the opinion of the experts the cost effectiveness of these measures is medium.

Soil experts pointed out that a restriction of heavy machinery use is necessary. However, they estimate that the cost effectiveness of this measure is low. On the other hand farmers seem not to be concerned. The measure can decrease waterlogging, improve infiltration, increase soil capillarity and thus lower the risk of water erosion that is the main concern. However, it seems that other factors like intensive tilling have much higher influence on the erosion rates of the case study area.

Restrictions on the maximum amount of (liquid) manure application, restrictions on manure application to a certain time period, restrictions on the maximum amount of N- and P-fertilisation can be considered as standard practice. Soil experts consider that diffuse contamination was a relevant issue on the areas where intensive crops and they consider that restrictions on manure and fertilisation application can significantly reduce the problem. On their assessment the cost-effectiveness of this measure is very high. They also think that vegetated strips could be very cost-effective in reducing diffuse contamination, therefore pointing out the interest of introducing vegetated strips as a common practice in the case study area.

5.2 Long term measures

Long term measures applied by farmers in the case study of Guadalentín are:

- Adding organic matter to soil
- Irrigation management and control of water quality
- Construction and conservation of soil conservation structures

Long term measures that are not frequently applied are:

- Change of crop rotation

The change of crop rotation is in the opinion of experts a highly effective measure to fight the decline in organic matter and diffuse contamination and with a medium cost-effectiveness for water erosion. However, for farmers these changes in crop rotations can not be simple and easy as the crop rotation in the Guadalentín is determined by market-driven, intensive

irrigated agriculture. Farmers grow and rotate their crops according to market demands. On rainfed agriculture rotation is not common as the environment is so restrictive that the only annual crop is a cereal, and the alternate is fallow.

Adding organic matter to the soil is considered by experts as a highly cost-effective measure to control organic matter decline, and also, because of the improvement in soil structure and infiltration capacity it is moderately cost-effective in preventing water erosion. On the contrary, farmers perceive it as very expensive. However, the sources of organic matter in the case study area can only come from crop residues with an abundance on irrigated crops as in rainfed crops primary production is low. Therefore, organic matter sources can be manures, especially from the very well developed pig farming, or from recycling urban refuses. Both sources are quite problematic. The excess of the application of manures produces diffuse contamination and is one of the soil degradation problems to be controlled. Urban refuses in the region have the problem of bad separation in origin generating compost of low quality. Moreover, the largest composting plant in the region process co-compost urban refuses with sewage plant refuses. Residues from sewage plants are usually rich in heavy metals. Because of the high alkalinity of soils in the region and the aridity of the climate the metals become much more immobile in the soil than in northern countries but it is still a hazard that farmers do not want to take. Therefore, the improvement on quality of these sources of organic matter is a necessary step to implement the measure.

The construction and conservation of soil conservation structures is considered by experts as a moderately cost-effective measure for soil conservation. However, this view can be influenced by plot-scale reasoning. At the landscape scale, the frequency of soil conservation structures can exponentially reduce fluxes of water and sediment in the landscape. On the other hand, 75 % of farmers respect vegetated banks and 25 % of them conserve stone walls (a costly task) indicating that they are much more prone to adopt this kind of measures that reduced tillage or similar. With no doubt traditional knowledge and culture of farmers is in the origin of this attitude and could be well exploited in soil conservation in the case study area.

Although the experts consider that water quality control and the management of irrigation are highly effective measures they are probably the most difficult measures to be adopted as water shortage is so extreme that farmers frequently accept bad quality water sources in order to save crop and/or yield during drought.

5.3 Conclusion

In the Guadalentín case study area the main problems identified by experts are soil erosion by water, diffuse contamination, the decline in organic matter and soil compaction. The application of soil conservation measures by farmers is influenced by their costs but also by traditional beliefs and knowledge. Water as the primary resource is the main driver and facilitating water infiltration and reducing water competition the goal of farmers. Nevertheless, the Guadalentín basin is a heterogeneous agricultural landscape marked by a strong duality between intensive irrigated agriculture and rainfed agriculture. In the latter cultural and cost problems are associated to implementing soil conservation measures. In the former market-driven products highly profitable do possible to the farmer to temporarily cope in a large extent with soil degradation without adopting soil conservation measures.

In general, the adoption of soil conservation measures is still relatively low in the region, with the most popular measures related to less intensive tillage and in some extent conservation of structures, and water quality control. There is still a wide range to extend these measures, but also there is a ground to the introduction of no frequently used measures like the creation of vegetated strips, reducing inputs of fertilisers and manure increasing the addition of exogenous organic matter. However, it will require changes in (farmer) education, culture and financial tools to support extra costs, especially on marginally profitable rainfed agriculture. Other types of measures such as those related to salinisation can be more problematic.

6 Soil related actors

6.1 Actors in the farming practices arena

6.1.1 Description of characteristics and attitudes

There are 13,227 farms in the case study area. The average size is 16 hectares, with an average of 8.5 hectares of UAA. A vast majority are individual farms (12,666 farms), while 339 are limited companies, 13 are public entities, 25 are cooperatives, 45 are Agricultural Transformation Societies (SAT) and 139 have another type of legal status. Regarding land tenure, 77.8 % of the UAA is owned by the farmer or the agricultural holding, while 21.8 % of the UAA are leased. Table 5 shows the characteristics of the interviewed farmers.

Table 5: Characteristics of the farmers interviewed

Affiliation/position of the interviewee	Crops	Size of farm [ha]	Location	Practices (*)	Participation in AES
Individual farmer	almond, olive, vineyard, pastures	15	mountain	TFCL, CT, TER, STW, HED, PRU	erosion
Part-time non-professional farmer	almond, olive, cereals, pastures	20	valley	TFCL, TER, HED	
Individual farmer	almond, olive, cereals, vineyard	137	mountain	TFCL, CT, TER, STW, HED, COV	erosion, integrated control
Individual farmer	almond, cereals, irrigated horticulture (broccoli)	117	valley	TFCL, CT, TER, STW, HED, COV	erosion
Individual farmer	almond, cereals	183	mountain	TFCL, CT, TER, STW, HED, PRU	
Individual farmer	almond, cereals, irrigated horticulture (broccoli)	6	valley	TFCL, TER, HED, COV	organic agriculture
Individual farmer	almond, olive, irrigated horticulture (artichoke)	89	valley	TFCL, CT, TER, STW, HED, COV	erosion
Private enterprise, manager of the farm	irrigated horticulture (broccoli and artichoke)	25	valley	TFCL, TER, STW, HED	

Own presentation.
(*) TFCL: tillage following contour lines; CT: conservation tillage; TER: terraces; STW: stone terraces; HED: hedgerows; PRU: soil covered with grinded remains of pruning; COV: vegetation covers.

None of the interviewees has a university degree of any type and only three of them have professional agricultural studies. All of them attend technical courses and workshops, and five of them usually read agricultural technical books and magazines. Their knowledge on soil conservation practices comes mainly from their own practice and advisory services. Three farmers use the advisory services of the local agricultural offices (OCA), while five use those of their agricultural cooperative, two get advice from input suppliers and two from other farmers. Three of the interviewed farmers defined themselves as very early adopters of innovations, while three defined themselves as being in the group of first adopters of innovations, while two adopt innovations once they see that a majority has done it. On five farms the farmer's son or other relative intends to continue with the farming activity in the future, while another two farmers intend to lease their land when they retire.

For six of the interviewed, farmers are well represented by agricultural organisations, but think they have little influence on the design of new policies with environmental content, and this would reduce the policies' effectiveness. Farmers think they have more influence in policies related with market issues.

Six farmers use the services of their cooperative to fill and process their subsidy applications, while two complete applications themselves (one processes it through the OCA and the other through his bank office).

Four farmers have participated in the previous soil erosion agri-environmental scheme (AES), while one does not participate because his farm's average slope is below the required slope, and three other farmers do not participate because they are not aware of the measure. When asked how they would incentivise participation in these programmes and adoption of conservation practices (an open question), three responded "with greater payments", two said "by showing farmers the advantages of these practices and providing technical advice", and one claimed both the above is necessary (two farmers did not respond). The four participant farmers think that the administrative process should be improved and criticise the delay in payments. In two cases, farmers complained about the lack of information on agri-environmental programmes and soil conservation measures.

Farmers in the area perceive soil erosion as an important problem, but they think it is more a problem of other farmers than their own, and the economic costs associated are not important, what explains the limited implementation of erosion control practices in the area. Soil conservation is not their top priority. For farmers in the area, water resources is the main issue of concern regarding their agricultural activity (even for farmers that do not irrigate), followed by the marketing of their products and the development of new crops and varieties, and soil conservation in the fourth place before other issues such as plant protection (Calatrava and Gonzalez, 2008, based on a survey to 200 farmers in the area, with a sample slightly unbalanced in favour of the dry-land areas). These percentages are similar to those for the eight interviewed farmers. Salinisation is also perceived as an important problem, but it is not cited isolated but as a component of the water resources problem.

6.1.2 Factors influencing adoption of soil conservation measures

Farmers interviewed were asked about their knowledge of policies with relation to soil conservation. The policy measures, schemes, initiatives and regulations with the objective of soil conservation that are known by the interviewed farmers are listed in Table 6.

For farmers, the main reason for participating in the voluntary measures is that the payments to be received compensate the increase in costs from the required practices. However, there are soil conservation practices that have been adopted by some farmers without compensation or obligation, only because they perceive a benefit. E.g., two farmers adopted the practice of covering soil with the grinded remains of pruning several years ago. This practice is neither included in the CAP, nor in the GAEC nor in the requirements of the 2000-2006 soil erosion AES. In the 2007-2013 soil erosion AES this practice has been included, but as a voluntary practice with an additional payment to the basic practices required.

Another similar example is the practice of conservation tillage, which was adopted by three of the five adopting farmers before their first participation in the soil erosion AES. These farmers stated that they decided to participate in the soil erosion AES because they already did most of the required practices, and the marginal cost of participating was very small. A similar response was given by the farmer participating in the organic farming AES.

Farmers in the area think that the main drawbacks for the soil erosion AES, as well as for other AES, are (in order of importance) the lack of technical advice regarding the practices and their practical implementation, the difficult and time-consuming administrative requirements and the amount of payments (Calatrava and Gonzalez, 2008). Similar responses have been obtained by Franco (2009) for the soil erosion AES in olive farms from the Southern Spanish province of Granada.

Table 6: Farmers' awareness of policy measures, schemes and regulations

Known policy measures, schemes, initiatives and regulations	Policy measures, schemes, regulations actively involved with (number of farmers that know the measure)	Reason for adoption
Single payment/Cross Compliance	7	compliance is mandatory and required to receive farm payments
Nitrate Directive and related national policies	5	mandatory, as it prohibits certain practices
Organic production AES	5	participation is voluntary but required if payments are received
Soil erosion AES	5	participation is voluntary but required if payments are received
Integrated control AES	5	participation is voluntary but required if payments are received
Integrated production AES	5	participation is voluntary but required if payments are received
Forestation of agricultural lands	6	participation is voluntary but required if payments are received

Own presentation based on interviews to farmers. Number of farmers = 8

Lastly, seven farmers did not perceive the organic farming and integrated production AES as soil conservation policy measures. The same applies to the Nitrates Directive. The reason is that they relate soil conservation with the problems of soil erosion, salinisation and loss of organic matter, but not with pollution.

Regarding mandatory schemes, the main reason for adopting the prescribed practices is the obligation to comply with them. However, many of the practices required for the GAEC standards under cross compliance were already applied by some farmers before the Single Payment Scheme started in 2003, and were perceived as effective by farmers. The main criticism was related to technical restrictions such as the minimum slope for practices to be compulsory[6], and to the compliance with the statutory legal requirements which they perceive as more complicated to comply with in absence of compensations.

Regardless of public policies, factors that influence the adoption of soil conservation practices are numerous. The first one is the profitability of the adoption. Some practices may reduce yields, what should be compensated with a reduction in costs. This cost reduction should be achievable for the farmers to adopt the practice. Climatic factors are also important. For instance, most interviewed stakeholders in this study believe that a main constraint for the diffusion of no tillage practice is the low regime of rainfall in the region, and that no tillage is more commonly found in irrigated fruit production. In this regard, Franco (2009) found that the speed of the diffusion of no tillage among olive farmers in the Granada Province in the period 1984-2004 was positively related with the price of fuel and with rainfall and inversely related with the price of herbicides.

Other factors that have been found positively related with the adoption of soil conservation practices in other studies in Spain are farmer's youth, family farms and continuity of farming by a relative (Calatrava et al., 2007, for no tillage in olive farms in Andalusia, and Franco and Calatrava, 2008, for no tillage in olive farms in the Granada province).

[6] Following contour lines is compulsory in slopes greater than 10 %, while tillage is forbidden in vineyards, olive and nut trees, in slopes greater than 15 % (unless terraces or vegetation covers exist). Interviewed farmers find these percentages excessive.

Results from these studies show that the probability of a farmer adopting no tillage diminishes with farmer's age and is greater for family farms and for farms in which some relative intends to continue with the agricultural activity when the current farmer retires. Franco and Calatrava (2008) also found that the probability of the adoption of no tillage increases with farm size and with farm slope and is greater for irrigated farms.

These results from other areas indicate that encouraging younger people to enter or continue with the family farming activity may help the adoption of this soil conservation practice, something that is consistent with responses given by the interviewees in this study that will be commented later on.

6.2 Actors in the policy design and implementation arena

There is not an explicit and consistent network of actors for soil conservation policy, as soil conservation is a by-product in several different policy measures. Actors in the arena of each policy measure know each other very well but the group of actors is not always the same which results in a communication deficit between the actors involved in various policy measures.

The main actors in the delivery of policies are the National Government and regional governments, Agricultural organisations (such as farmers' unions, agricultural cooperatives, WUAs and large agricultural holdings), and, to a much lesser extent, town councils, research centres and universities, and environmental NGOs.

According to most interviewees, the key actors in the case of the Murcia Region are the Regional Government and agricultural organisations, mostly large agricultural holdings and the Federations of Agricultural Cooperatives. Farmers' unions, although active in the policy process, have a secondary role in the region. Town councils, research centres and environmental NGOs have little influence on the whole agricultural policy process.

6.2.1 Governmental organisations

According to the respondents, the main governmental actors in policy design are the Spanish Ministry of Environment and Rural and Marine Areas (MIMARM) and the Regional Government of the Autonomous Community of Murcia (CARM).

The Ministry of Environment and Rural and Marine Areas (Ministerio de Medio Ambiente y Medio Rural y Marino, MIMARM) has been recently created by merging the Ministry of Agriculture, Food and Fisheries (Ministerio de Agricultura, Pesca y Alimentación, MAPA) and the Ministry of Environment (Ministerio de Medio Ambiente, MIMAM). However, it maintains a formal separation in two areas (Environment, that corresponds to the former MIMAM, and Rural and Marine Area, which corresponds to the former MAPA).

The MIMARM acts at the national level, defining the policy framework for the Common Agricultural Policy that is designed by the EU and implemented by the regional governments. Regarding agricultural soil conservation policies, the MIMARM establishes the national framework legislation for the application of the Nitrates Directive, the Rural Development Regulation, Common Market Organisations, Single Payment Regulations, etc. Although the MIMARM acts at the decision level, it also participates in the policy planning process.

The responsibilities of each governmental actor are determined by the Legislative development of the 1978 Spanish Constitution that established a decentralised structure for the Spanish State. Political power is shared by the National Government (Administración General del Estado) and the 17 Regional Governments or Autonomous Communities (Comunidades Autónomas) and the two Autonomous cities in the North of Africa. Responsibilities or competences over each matter were, and are being, transferred to the Regional Governments according to the agreements reached and established in each Region's Autonomy Statute (Estatuto de Autonomía). The Autonomy Statute of the Murcia Region, approved in 1982, states that the Regional Government is responsible for the

legislative development and implementation of issues such as agriculture, forests and forestry, physical planning and development of infrastructures located solely within the region, water planning management in basins that are completely within the region's territory, environmental management, nature conservation, and economic development of the region. All regional policy initiatives must be in accordance with the national economic development policy.

However, as the Segura river basin, where the Murcia region is located, comprised territories belonging to three other Autonomous Communities (Andalusia, Valencia and Castilla La Mancha), water planning and management are the responsibility of the National Government through the Segura River Basin Authority (Confederación Hidrográfica del Segura, CHS), that is located in the city of Murcia. Among other issues, the CHS is responsible for flood prevention, control of effluents discharge to water bodies, water infrastructures building and Forest-Hydrological Restoration. The CHS is somewhat influenced by regional political powers, but its top positions are decided by the National Government and usually act according to the National Government's decisions. In recent years, legislation has changed to increase the influence of the Regional Governments in the planning process.

Regarding agriculture, the National Government has the sole responsibility, among other issues, for foreign trade, coordination and fostering of research, foreign food safety and the general coordination of food safety. The role of the National Government is mostly limited to being the link between the EU regulations and its regional implementation and to coordinate inter-regional initiatives such as the National Irrigation Plan.

The Regional Government of the Autonomous Community of Murcia (CARM), through its Department of Agriculture and Water, acts at the regional level, and participates in the design, panning and implementation stages. Regarding agricultural soil conservation policies, CARM establishes and implements the agri-environmental schemes and other Rural Development Programmes, such as the forestation of agricultural lands, the application of the Nitrates Directive in the region, the Single Payment Scheme, etc. That is, it is responsible for the design, the administrative implementation and the monitoring of agricultural soil conservation policies.

6.2.2 Civil society and non-governmental organisations

Farmers' representation is multiple. On one hand, the three main Spanish agricultural unions[7] are present in the Murcia region, with COAG being the most important in terms of farmers' representation. Second, many small to medium farmers belong to one of the agricultural cooperatives, which are represented by two large organisations (FECOAM and FECAMUR). According to some of the interviewees, FECOAM and FECAMUR have even more influence on regional agricultural policy than farmers' unions[8]. Finally, farmers in irrigated areas usually belong to one of the Water User Associations (WUAs) that share a common public water concession as well as common water infrastructures. WUAs act at the local level and are responsible for the management of irrigation districts and the modernisation of irrigation structures.

It has to be pointed out that the above holds for most small to medium farmers. However, there are important large agricultural holdings in the region that act as large private enterprises and do not belong to any farmers' union, cooperative or WUA. They usually have large marketing infrastructures, their own water concessions and their own organisations. Some interviewees that do not belong to the Regional Government stated that they have more power than any other agricultural organisations, as also pointed put by Oñate et al. (2002). But these enterprises are more focused to other policies not directly related with soil conservation.

[7] COAG (Coordinadora de Organizaciones de Agricultores y Ganaderos), UPA (Unión de Pequeños Agricultores) and ASAJA (Asociación Agraria de Jóvenes Agricultores).

[8] Interviewees from the Regional Government indicate that their influence power is similar.

The main demand from all agricultural organisations in the region is an increase in water supply for irrigation. This is an issue that arises in all interviews with farmers or agricultural representatives in relation with any other matter such as the marketing of farm products or soil conservation.

There are several NGOs that are active in the region, Ecologistas en Acción - Región Murciana and Asociación de Naturalistas del Sudeste (ANSE) being the most important ones. They are active at the participative level, denouncing environmental damages and elaborating reports and studies. However, they are more active in the area of wildlife protection and water pollution than in agricultural soil conservation. They are more concerned with non-agricultural land turned into irrigated areas because of the damages to land and wild plants.

Regarding the advisory systems, the main source used by farmers are the technical advisors in the agricultural cooperatives. According to Calatrava and Gonzalez (2008), 80 % of farmers in the area use the advisory services of agricultural cooperatives, while 30 % use the Local Extension Services, 15 % get advice from agricultural inputs suppliers and 8 % from other farmers.

In the region there is a good research infrastructure and active teams on soil research, conservation and restoration as well as in agricultural economics and policy. There are several research teams focused on soil sciences both in the University of Murcia and the Technical University of Cartagena (UPCT), the two public universities in the Murcia region. There is also an agricultural research institute (IMIDA) that depends on the Regional Government and another research institute (CEBAS) that depends on the National Research Council (CSIC) where soil restoration and use of wastes in agriculture and soil restoration is currently a main research interest. There are two agricultural economics research teams in the region: one in CEBAS-CSIC and another in UPCT. The UPCT team has participated in two National Research Projects on the economic valuation of soil erosion and the adoption of soil conservation practices in South-Eastern Spain. The local universities and public research centres are active actors in the field of soil conservation policy, but focus rather on technical aspects than on economics and policy. Soil scientists from IMIDA, CEBAS-CSIC and UPCT have participated as consultants in the design of soil conservation policies.

6.2.3 Resources, capacities and networks

Policy design

At national level expert committees as well as the National and regional governments are working on policy design. In most cases agricultural organisations are consulted such as the different farmers' unions and the National Confederation of Agricultural Cooperatives (CCAE) that represent a majority of agricultural cooperatives is the country. In some cases, environmental NGOs are also consulted.

The only policies concerning soil conservation that are designed at the regional level are the agri-environmental schemes (AES). Other relevant policies, such as Single Payment/ cross compliance standards or nitrate pollution policies, are adapted from the national ones. The most important actor for regional level policy design is the Regional Government of the Murcia Region (CARM), through its Department of Water and Agriculture. Most interviewees stated that the most important non-governmental actors in the field of agricultural policy design are the agricultural organisations. However, although they participate in policy design, and sometimes their proposals are accepted, they lack of effective decision power. The interviewed officers from local Agricultural Offices miss some participation in the design of the policies in which implementation they participate, as the design of policies at the regional level is in the hands of a few top-level officers in the capital of the region. The role of research institutes and universities is limited to their participation in experts' committees or studies. These are related to the technical side of the policies (mostly related to the practices to be required from farmers), but not to social, economic or institutional aspects. The

remaining actors identified have little influence on the whole policy process. There is no participation of the local administration in the design of agricultural policies.

The relation between the National and Regional Government and the other actors that participate in the design process, mostly agricultural organisations, has the characteristics of a classic consultation process. The stakeholders receive drafts and can make written contributions, and in some cases participate in working groups where they can express their opinions, but in most cases they do not see their comments and suggestions in the legislative acts. In the case of environmental NGOs, if they are consulted (the exception more than the rule), they find that the main interest of the administration is agriculture rather than the environment, so their suggestions are rarely taken into account. Recently, the National Ministry of the Environment has been merged with the Ministry of Agriculture, but the agricultural and environmental sections are still somehow working as separate ministries. In the Murcia region, the Agriculture and Environment Departments used to be merged in the past, and now are separated in different departments, but the main focus of agricultural policies was and still is on agriculture.

As an example, the new Regional Rural Development Programme 2007-2013 (CARM 2007) has been designed by the Regional Government. In the process, soil science experts and agricultural organisations have been consulted. Even one new agri-environmental measure has been proposed by the farmers' union UPA (Environmental integration in vineyards). Agricultural organisations claim their proposals regarding other AES, such as the soil erosion AES, have not been taken into account. In the case study area, as in the rest of the Murcia region, agricultural cooperatives have more influence capacity than farmers' union, whereas at the national and European level they exert more influence in the design of policies. To increase their influence on policy design, farmers' union cooperate with other farmers' unions and agricultural cooperatives to provide a unitary proposal, as they did in the case of the new regional RDP 2007-2013.

Regarding the effectiveness of the interactions among actors, communication among the main actors is perceived as good. In general, there are conflicts of interest but not to the point of aborting initiatives. Officers from the regional administration think that the Spanish Ministry of Agriculture (MIMARM) is mostly an intermediary among the regional governments and the EU, and that makes communication more difficult. They claim for direct communication with the EU.

Interviewees from agricultural organisations (unions, cooperatives and WUAs) think that communication with the regional administration is good but, as it is based on working groups, it is also slow. In their opinion, this delays the development of new legislation as well as policy implementation, which ultimately results in delayed payments to farmers. These interviewees claim for more dialogue and better access to information from the Regional Government (e.g. data on participation in past programmes should be more easily available).

For agricultural organisations and academic interviewees, former agri-environmental policies, both designed by the National and Regional Government, are very general and far from the reality of the agricultural systems they are targeted at, and therefore of little effectiveness. Requirements should be more locally adapted. However, interviewees also criticise the complexity of some AES in the new RDP due to the complexity they have to allow for a better targeting and more flexibility, what is somehow contradictory. Regarding policies with soil conservation objectives or requirements, these interviewees recognise some positive outcomes from cross compliance rules and AES in terms of increased adoption of some basic conservation practices, but they think that their impact has been reduced in relation to their potential.

Several interviewees comment that the potential for the targeting of policies, mostly referring to AES, is easier to achieve in regions with one province, such as Murcia, than in regions with several provinces, such as Andalusia or Castille, and more heterogeneous agricultural systems.

One academic interviewee comments that soil conservation policies leave aside the most intensive horticulture and fruit production that barely receive EU subsidies. Another interviewee says that this more profitable agriculture is in areas of low risk of soil erosion, and that they would need large incentives to enter AES, and even larger ones to reduce their use of polluting inputs. However, it has to be said that fruit growers in the area are increasingly adopting soil conservation practices, such as using the grinded remains of pruning operations for mulching. This is a practice they are increasingly recognising as economically sound, and effective for soil conservation and increasing organic matter. This practice was not included in the requirements of any AES or in the cross compliance requirements. This could be interpreted both in the sense of no need of incentives for the most profitable sectors of agriculture and in the lack of local adaptation of required farming practices. Organic farming is also increasing among horticulture and fruit production farmers, although they claim that this is more a response to market forces than to AES, which they label as bureaucratic and difficult to enter for farmers.

With respect to the knowledge needed for a more effective policy design, most interviewees claim that there is enough technical information about soil conservation practices and their effects, but there is a lack of knowledge on the problems farmers face when adopting certain practices, social and economic impact of policies, attitudes of farmers towards the adoption of practices and towards policies. Furthermore, academic interviewees claim that there is a lack of integration of different knowledge (technical, environmental, social and economic). However, officers in the administration showed little interest in obtaining more information regarding potential for adoption of practices and their economic impact. In fact, they only consulted soil science experts in the design of the new 2007-2013 AES. Their view is that the various AES are economically attractive to farmers and their budget is so limited, so they do not see a problem in farmers' attitudes towards the adoption of practices, as they are sure that applications for subsidies will exceed the available funds. On the other hand, officials expressed a concern for the lack of evaluation of the real environmental impacts of policies, rather than the administrative-oriented evaluation of programmes that is usually performed.

In this sense, another problem pointed out by some interviewees is the lack of data regarding the extent to which soil conservation practices are applied, i.e. the number of farms and area in which a given practice is performed. They only have data for farms that participate in some AES or that receive single payment subsidies and only for those that are effectively inspected. There is no knowledge of the conditions of soils at the farm level. For instance, in the case of soil erosion, measures are targeted to areas where the risk of soil erosion is higher, not where soil erosion is indeed greater.

At the local level no relevant decisions concerning agricultural soil conservation policies are taken. Local authorities do not have the possibility to pass laws that concern agricultural soil conservation. Their only related responsibility is that of discharges to the domestic water sewage system from some farms that may be connected to it. They also have the responsibility for local development plans that may approve the conversion of agricultural land to urban or industrial uses but these plans do not focus on soil conservation.

Policy implementation

Although there is a good base of soil knowledge, there is no specific structure in charge of soil monitoring and assessment. This is a drawback as processes leading to soil degradation have been very intense in the last decades. The enforcement and monitoring of policies related to agricultural soil conservation, as well as sanctions for non-compliance, is now basically under the authority of the Agriculture Department (Consejería) of the Regional Government. The Regional government and its departments are independent from the River

Basin Authority, which depends on the National Government, and from other National Government Agencies.

The administrative implementation and monitoring of agricultural soil conservation policies is the responsibility of the Regional Government and undertaken through the local District Agricultural Extension Agencies (OCA[9]) that depend on the Agricultural Regional Department (Consejería de Agricultura y Agua). There are two OCAs in the area of study, one in Lorca that acts on the municipalities of Lorca, Puerto Lumbreras and Aguilas, and another one in Alhama de Murcia that acts on the municipalities of Alhama de Murcia, Totana, Aledo, Mazarrón and Librilla. OCAs officers assist farmers mostly in administrative issues, but to some extent also in technical ones.

Apart from the administration, agricultural organisations are an important actor in the implementation process. In fact, their participation in the implementation of soil conservation policy is greater that in its design. Farmers' unions and agricultural cooperatives play a very important role in helping farmers with the administrative burden of policies. Many farmers process their application for subsidies through them. This is an important reduction for farmers in the transaction costs of the measures. Apart from this, these agricultural organisations are a very important way for farmers to be aware of new policies and their implications in terms of farm management requirements, and agricultural cooperatives usually serve as advisory services for many farmers.

However, the role of agricultural cooperatives in advising farmers should not be overestimated. Their potential for advising farmers is very high, as they have close links to farmers, but it must be taken into account that they respond to what farmers demand and farmers do not demand a knowledge they think they already have. In interviews with technical advisors of cooperatives in the region, they commented that they barely receive questions from farmers regarding tillage or erosion control, as farmers think they already know how to plough. Most farmers' questions relate to plant nutrition, irrigation schedules and pest management related to compliance with standards set by quality control inspectors. In areas where the Single Payment Scheme and AES are relevant, farmers seem more interested but erosion control still marginal in farmers' consults to technical advisors. According to our own data in the area, there is no significant relation between adoption of the main soil conservation practices and the type of advisory system preferred by the farmers. The adoption of soil conservation practices is significantly related with the participation in AES, but more importantly with farm size, farmer's age, perception of the problem, education, agricultural training and risk attitudes. Farm size is an important variable as larger farms tend to have their own agricultural advisors.

The interaction between the administrations responsible for the implementation of the agricultural soil policy measures is perceived as good by most respondents. There is also a good cooperation among the administration and agricultural organisations in the implementation of policies. There is also some formal cooperation with town councils that frequently lend some office space, and even personnel, for the farmers in the municipality to present their applications without having to travel to other towns.

Most interviewees think that the implementation approaches should differ depending on the type of policy measure implemented. A majority prefer a combination of compulsory/ sanctions and voluntary measures. Three respondents from agricultural organisations prefer only voluntary measures based on financial incentives, but they recognise, as everybody else, that the lack of funds limits the possibility of giving priority to voluntary approaches. Two respondents from academic/research centres would be in favour of voluntary approaches as the default option, but keeping compulsory measures to specific problems and areas, but they also recognise the lack of funds to give priority to voluntary approaches.

[9] Acronym for Comarcal Agricultural Bureau. "Comarca" is an agricultural policy concept used in Spain that refers to a group of municipalities with common agricultural characteristics.

However, when the question of the type of approach they would prefer was posed to them, a vast majority stated that the most important and effective measure is providing technical education and information to farmers to convince them of the benefits of conservation practices, regardless of whether voluntary or compulsory approaches are chosen. In this regard, they pointed out three main issues. First, the important role to be played by technical advisors to farmers (in most cases from cooperatives), that should be convinced in the first place of the benefits of soil conservation practices. Second, policies will be more successful if knowledge is transmitted and farmers are convinced prior to giving economic incentives to them. Third, soil conservation practices would be more easily spread if the market would demand soil conservation. If consumers would demand soil conservation practices in agricultural production, as they do with organic farming, farmers would be more easily convinced.

The most important factors for a successful policy implementation for the stakeholders interviewed are (in order of importance):

- Change the mind of farmers and their technical advisors regarding soil conservation.
- Education in soil conservation practices.
- Favour younger and more professional farmers entering the activity.
- Policies should have clear and easy to understand technical and administrative requirements for farmers. This is of special importance regarding the Single Payment Scheme, as many interviewees, even from the regional administration, criticise its design as obscure.
- Reduce bureaucracy through lower implementation cost measures.
- Give priority to voluntary incentive-based approaches, what requires increasing available funding.

Regarding the availability of resources for implementation, all interviewees agree that sufficient funds are lacking. Regional officers and agricultural organisations disagree regarding administrative capacity: the former think that there is enough administrative and technical capacity, whereas the latter think there is not enough staff. Interviewees from research and academic centres disagree that the important issue is the administrative capacity: they think that the administration is extremely bureaucratic and its structure is designed to manage EU funds and funding applications. Several respondents think that there should be more coordination between the Department of Agriculture and the Department of the Environment. If new administrative units in charge of soil conservation policies were to be created they should be in the Department of the Environment, to partially offset the agricultural bias.

For most agricultural policies the implementation process is as follows: Farmers present their applications through several ways (OCAs, farmers' unions, cooperatives, bank offices and others). All applications go to the corresponding Service in the central offices of the Agriculture Department in Murcia where they are processed[10]. The Regional Agricultural Department decides upon the approval or rejection of the applications and communicates it to farmers, and it is also the paying agency.

All applications are subject to an administrative control that includes checking the area and location of farms and parcels, and compliance of the information contained in the application form with the requirements stated in the measure.

If a farm has to be inspected on-site, inspections can be made either by the OCA staff or by staff in the central offices. Inspectors are high graduates such as agricultural engineers, veterinaries, etc. In some cases, inspectors belong to the regional administration and in others to an external subcontracting enterprise (a common practice in both the regional and

[10] In the case of regions with more than one province, there is an office of the Regional Agriculture Department in each province that processes the applications.

national administration in Spain). Inspections are done according to EU, national and regional legislation.

Inspections are based on on-the-spot checks to a percentage of farmers submitting aid applications that depend on the programme monitored (1 % for the single payment, 5 % for AES, although the final percentage of controlled farmers is marginally higher). Inspections check whether the farmers comply with the requirements stated in the measure. The selection of controlled farmers is partially random and partially based on a risk analysis. The risk analysis is based on pursuing economic frauds. The results of the monitoring do not have an effect on the programme, only on the farmers' file and the future risk analysis. Officers from the extension offices (OCA) may suggest to check specific farmers if they suspect non-compliance.

Interviewees from the administration perceive the implementation process of policy measures as effective in order to achieve the policies' objectives, although interviewees think that more inspections should be done if finances were available. Officers from OCAs comment some problems with the accordance of the inspection calendar and the crop calendar, in the sense that some practices cannot be observed if inspections are not done in the appropriate time of the year.

Apart from the lack of administrative capacity for the implementation of policies by the Regional Government, agricultural organisations and farmers also complain about the strictness of inspections. They also complain that some practices are checked more than once, and that inspections for different programmes (compliance with requirements of the Single Payment Scheme and the different AES) should be integrated in one single inspection. In this regard, officers form the administration claim that these programmes are processed by different sections of the Agriculture Department, but agree that integration of inspections would reduce administrative costs.

All interviewees think that farmers are aware of sanctions and that these are in general a deterrent, but one academic thinks that this awareness is greater in irrigated agriculture than in rainfed agriculture.

Regarding the evaluation of policies, research/academic interviewees and administration officers think that the evaluation of soil conservation policies is limited to the administrative level. They claim that no proper evaluation of its environmental, social and economic impact is performed, although regional officers think the MIMARM or the EU should do it. Half of the interviewees are not aware of whether any evaluation is performed.

6.3 Conclusions

Soil conservation is perceived as a serious problem in the study area by the interviewed stakeholders. However, it is not a priority for any of the representatives of agricultural organisations, NGOs and administrations interviewed. For administration officers, soil conservation has the same importance as other environmental problems but no more. Only respondents from universities and research institute consider that it should be a top priority.

The number of stakeholders involved in the policy process at the regional level is small and for most of them soil conservation is not a main priority. Most of the regulations originate from the European Union and are first implemented into national laws and later into regional acts. This implies that the EU is really the key actor in the design of policies.

Apart from the European Union, the main actors in the design and implementation of agricultural soil conservation policies are both the National and Regional Government and agricultural organisations. Most political power regarding the agricultural sector lies increasingly with the Regional Government. For most policies, the National and Regional Government can adapt polices to national or even regional conditions, but maintaining the basic framework of the schemes as established by the EU. The policies in which National and Regional Government have more space for further adapting the EU design are agri-

environmental schemes. In the period 2000-2006, the National Government was the main actor in designing the AES, including the requirements for each one, while Regional Governments could decide which AES of those established by the National Government to implement and if some requirements were added. For the 2007-2013 Rural Development Programmes, the Regional Government has been given more freedom to design their own schemes within the main framework set by the EU and the National Government.

The only non-governmental organisations that take part in the design process of soil conservation policies are agricultural organisations, that is, both farmers' unions and agricultural cooperatives. However, soil conservation is not among their top priorities. Large agricultural holdings and the Federations of Agricultural Cooperatives have greater influence, although the latter are mostly interested in policies other than soil conservation. Farmers' unions, although active in the policy process, have a more secondary role in the region compared to the national level. Town councils, research centres and universities, and environmental NGOs participate in some aspects of the agricultural policy process but have little influence on it.

The role of research institutes and universities is limited to their participation in experts' committees or studies. These are related to the technical side of the policies (mostly related to the practices to be required to farmers), but not social, economic or institutional aspects.

There is no participation of environmental NGOs in the design of agricultural soil conservation policies. In general, they give more priority to the conservation of non-agricultural soils.

Regarding policy implementation, the whole process is in the hands of the regional administrations. The only additional actor that is active in this process playing an important role are the agricultural organisations, mostly the agricultural cooperatives, that play a double role by advising and providing administrative support to farmers. There is also some marginal participation of town councils in the implementation process of agricultural policies.

7 Policies for soil conservation

7.1 Existing policies and their classification

Most of the policies in the case study region can be classified as compulsory or command and control policies (Table 7). For most policies, farmers are subject to either fines or penalties if they do not comply with the requirements in the measures. There are also some voluntary and incentive measures, such as the AES and the Single Payment[11].

[11] There was a controversy among interviewees regarding the compulsory or voluntary nature of the Single Payment Scheme. For administration officers it is a voluntary approach, something they criticised, while for Agricultural organizations and farmers it is a compulsory scheme as new requirements are added to an already existing subsidy that is perceived by them as legitimate.

Table 7: Classification of policy measures in Guadalentín area (Murcia, Spain)

Type of Policy Mechanism/ Mode of governance	Practical classification – Nature of the Policy Objective			Policy relationship to agriculture	Geographical level	Analytical classification – Channels of Impact. Primary (1) and Secondary (2) impacts. Y = Yes, N = No		
	Soil conservation is the **primary objective** of a policy measure	Soil conservation is the **secondary objective** of a policy measure	Soil conservation is a **by-product**	Agricultural (AG) or non Agricultural (NAG) focused policy	European (E), national (N), regional (R) or local (L) measure, and policy reference	Developing new/altering existing rules (institutions)	Developing and/or altering governance structures/ implementation approaches	Directly impacting on farmer behaviour/ decision making/ factor allocation and management practices
Command and Control			Restrictions and limitations on the use of nitrates in vulnerable areas during certain time periods	AG	E European Nitrates Directive (91/676EEC), N implemented in Spain by Royal Decree 261/1996	Y Setting up new rules: Code of Good Farming Practices; Soil and Water Analysis; Establishing Nitrate Vulnerable Zones (NVZ)	Y Development of new governance structures to support NVZ allocation; The programmes set to implement the Directive must be incorporated into Water Planning and Management	Restrictions and limitations on the use of nitrates in vulnerable areas during different time periods. Also applies for farmers receiving direct payments
	Integration of soil conservation in national sectorial policies and prevention of further soil degradation. Main focus is on soil erosion			NAG	N National Action Program to fight against desertification (August 2008)	N	Y Development of an Integrated System for Evaluation and Monitoring of Desertification	N Requirements for good farming practices are those in already existing agricultural policies
			Integrated water policy at the European level to increase the environmental quality of water bodies by 2015	NAG	E EU-Water Framework Directive (2000/60/EC), N Implemented in Spain through Law 62/2003 that modifies the Water Law (Royal Decree 1/2001)	Y Development of new water quality criteria and standards	Y Development of new governance structures to achieve the Directive's objectives	Y Reduction of nutrient supply on ground and surface waters and increase in water prices

Type of Policy Mechanism/ Mode of governance	Practical classification – Nature of the Policy Objective			Policy relationship to agriculture	Geographical level	Analytical classification – Channels of Impact. Primary (1) and Secondary (2) impacts. Y = Yes, N = No		
	Soil conservation is the **primary objective** of a policy measure	Soil conservation is the **secondary objective** of a policy measure	Soil conservation is a **by-product**	Agricultural (AG) or non Agricultural (NAG) focused policy	European (E), national (N), regional (R) or local (L) measure, and policy reference	Developing new/altering existing rules (institutions)	Developing and/or altering governance structures/ implementation approaches	Directly impacting on farmer behaviour/ decision making/ factor allocation and management practices
			Single direct payments linked to compliance with environmental, animal welfare, food and animal feed security requirements	AG	E- Single Payment Regulation 1782/2003 N implemented in Spain by the Royal Decree 2352/2004 that applies Annex IV of Regulation 1782/2003 (Good Agricultural and Environmental Conditions)	Y Setting up new rules: GAEC; compliance with other previous regulations; reduction of payments depending on the severity and continuity of infringements	Y Development of new governance structures such as the Integrated Agricultural Control System (IACS) to support the implementation of the measure	Y Compliance with the standards increases farmers' costs
			Establishment of an European network of reserves to contribute to the diversity of species	NAG	E - NATURA 2000 combines the Conservation of Wild Birds Directive (79/409/EEC) and the Flora-Fauna-Habitat Directive, FFH (92/43/EEC)	Y	Y development of new governance structures to support the implementation and control of both Directives	Y Farmers receive payments for doing certain practices
			Protection of ecosystems, natural assets, natural habitats of plants and animals and the diversity of nature	NAG	E Nature Conservation and Wild Flora-Fauna Law R Land Planning and protection of the Murcia region	Y Setting up new rules to require identification and implementation of areas with specific status	Y Development of governance structures to support the implementation and control of the measure	Y bans on the arable use of certain sites

Type of Policy Mechanism/ Mode of governance	Practical classification – Nature of the Policy Objective			Policy relationship to agriculture	Geographical level	Analytical classification – Channels of Impact. Primary (1) and Secondary (2) impacts. Y = Yes, N = No		
	Soil conservation is the **primary objective** of a policy measure	Soil conservation is the **secondary objective** of a policy measure	Soil conservation is a **by-product**	Agricultural (AG) or non Agricultural (NAG) focused policy	European (E), national (N), regional (R) or local (L) measure, and policy reference	Developing new/altering existing rules (institutions)	Developing and/or altering governance structures/ implementation approaches	Directly impacting on farmer behaviour/ decision making/ factor allocation and management practices
			Preventing hazards for human beings, animals and the ecosystem caused by the application of plant protection products	AG	E Plant Protection Products Directive (91/414/EEC)	Y Setting up new rules to require identification and implementation of the measure	Y Development of governance structures to support the implementation and control of the measure	Y restrictions on the use of certain plant protection products
		Controls and restrictions the application of sewage sludge		AG	E 86/278/EEC Sewage Sludge Directive, N implemented in Spain by the Decree 1310/1990	Y Setting up to new rules: soil analysis, limits and restrictions on the application of sewage sludge on certain areas	Y development of governance structures to support the implementation of the Directive	Y Prohibition of using sewage sludge on certain areas
Incentive based measures/economic instruments	E.g. encouraging soil erosion control practices such as vegetation covers and conservation tillage.	E.g. encouraging the rational use of chemicals (Organic Agriculture, Integrated Pest Control, …)		AG	E Agri-environmental scheme, R Murcia Region Rural Development Programme 2007-2013 (Programa de Desarrollo Rural de la Región de Murcia 2007-2013)	Y Setting up new rules for funding (e.g. co-financing by EU and National and Regional governments)	Y development of new governance structures to support the design, implementation and control of the scheme. Some AES are targeted to less area but in greater risk of environmental damage and with greater per ha payments	Y Farmers receive payments if they adopt certain practices during a period of time

Case study Spain

Type of Policy Mechanism/ Mode of governance	Practical classification Nature of the Policy Objective			Policy relationship to agriculture	Geographical level	Analytical classification – Channels of Impact Primary (1) and Secondary (2) impacts. Y = Yes, N = No		
	Soil conservation is the **primary objective** of a policy measure	Soil conservation is the **secondary objective** of a policy measure	Soil conservation is a **by-product**	Agricultural (AG) or non Agricultural (NAG) focused policy	European (E), national (N), regional (R) or local (L) measure, and policy reference	Developing new/altering existing rules (institutions)	Developing and/or altering governance structures/ implementation approaches	Directly impacting on farmer behaviour/ decision making/ factor allocation and management practices
Moral Suasion Initiatives i.e. it has a normative dimension that farmers should protect soils								
Information and capacity building measures								

7.2 Description, analysis, and evaluation of policy measures

Based on the relevance given by the interviewees for the soil degradation problems in the agriculture of the case study area, we have chosen the following examples for the policy fiches: The Single Payment Scheme, the agricultural soil conservation/soil erosion control AES, the Organic Agriculture AES and the Integrated Production AES.

The requirements in the Single Payment Scheme include many soil conservation aspects (Annex IV) and compliance with other legislative acts (Annex III). The main reason for choosing this policy is its importance in rainfed agriculture, as farmers are quite dependent on the single payment.

One Agri-environmental scheme has soil erosion as a main objective, while others have soil conservation as a secondary objective or a by-product. It is the measure preferred by most interviewees as it is the one that could be better adapted to regional o local conditions, and most of them ask for more funds to be made available for these measures.

Some interviewees have highlighted all rural development measures as providing benefits in terms of soil conservation, but the majority of stakeholders do not consider them the most relevant. First, forestation policies are perceived by some stakeholders as providing benefits in terms of soil conservation, but are totally rejected by agricultural organisations. They appear more as a solution to the degradation of abandoned land than a measure with the potential of a more widespread solution. Forestation of agricultural land has also been considered by MIMARM as a measure that could incentivise abandonment of agricultural land in irrigated areas with problems of aquifer over-exploitation. However, it is a very controversial measure in the region and, even recognising some potential to provide benefits in terms of soil conservation, is not considered a relevant measure.

Second, there are rural development schemes that subsidise investments in water-saving irrigation technologies (such as drip irrigation or fertirrigation[12]). These allow reducing water percolation and improving the use of fertilisers, thus having a positive impact on non-point pollution. However, it is not considered a really relevant measure for the stakeholders either.

Last, other rural development schemes such as those financing farm structures (e.g. planting of new varieties, modernisation of farm infrastructures, improvement of animal welfare conditions, etc.) or encouraging generational relief in agriculture, although they do not have a direct impact on soil conservation, are perceived by some stakeholders to have positive effects in the long run in terms of the adoption of conservation practices.

The Royal Decree 261/1996 on the protection of water against nitrate pollution from agricultural sources is often mentioned by the interviewees, but it is not applied in the case study area. Many stakeholders agree that the area should be declared as Nitrate Vulnerable Zone, although they think that it is difficult to implement but would be effective if it were successfully implemented. However, the general provisions of Cross Compliance in regulation 1782/2003 establish that any farmer receiving direct payments should observe the statutory management requirements referred to in Annex III, which includes the Nitrates Directive. Therefore, farmers in the area that are receiving direct payments (most of the dry land areas and a little of the irrigated ones) are being monitored by the Regional Agricultural Authority to check whether they are complying with practices in the regional “Good Agricultural Practices” code. Intensive horticulture and fruit producers in the irrigated areas do not see many problems in the Directive being implemented in the area, based on its application in other parts of the region and its low dependence on EU subsidies.

[12] “Fertirrigation” comes from the terms “fertilisation” and “irrigation” and refers to the joint application of fertilisers and water through an adapted irrigation system that improves and reduces the application of fertilisers.

Apart from the above mentioned specific measures, compliance with the Code of Good Farming Practices (GFP) is also necessary to participate in any measure of the Rural Development Programmes. For Spain, the GFP is established in the Annex I of Royal Decree 4/2001 and Royal Decree 613/2001 that applied Regulation 1257/99. Regarding soil conservation, the following requirements apply: prohibition of tilling following the slope's direction; implementation of crop rotation adequate for each land; efficient use of water resources; rational utilisation of pesticides, considering the vulnerable zones and the comparative levels established in both the "Nitrates Directive" and in the Autonomous Communities' Action Plans in the vulnerable zones; and the prohibition of burning stubble fields. Although being a very basic practice, tillage following contour lines has been widely adopted since its inclusion in the GFP.

The recent National Action Program to fight against desertification (NAPD, passed in August 2008 but subject to public discussion since the late 1990s) is not considered as a relevant policy measure for the agricultural sector by the interviewed stakeholders. Interviewees were asked about it as a forthcoming policy, and some of them knew it and had read the drafts. Although they find important that desertification is at last addressed, all coincided to consider it not relevant for agriculture from a practical point of view. The NAPD aims to the coordination of existing policies. Other objectives are to identify areas in risk of desertification, promote the forest-hydrological restoration of degraded areas, and finance research projects. For those stakeholders that were aware of the contents of the NAPD, it focuses on non-agricultural areas, and does not really add nothing new to agricultural sol conservation, as it aims to integration soil conservation in agricultural and environmental policy making, but relies on existing EU policies (basically AES measures), and does not include any new measure nor additional funding to incentive conservation measures. Two stakeholders pointed out that a lot of research was already being conducted on the issue and that it will only add some additional financing. A short overview of all relevant policies is included in Annex 3 of this report.

7.2.1 Fiche 1: Single Payment Scheme

Part A: Summary of Measure	
Formal title of measure and date of imple-mentation	Single Payment Scheme, also called Direct Support Scheme (Pago único), Commission Regulation 1782/2003; 01/01/2005.
Short descrip-tion of the measure	This measure establishes decoupled direct payments and compulsory cross compliance for farmers. Any farmer receiving direct payments should observe the Statutory Management Requirements (SMR) referred to in Annex III of the Regulation and Good Agricultural and Environmental Conditions (GAEC) (as defined in article 5 and Annex IV). The list of statutory management requirements and the good agricultural and environmental condition to be respected are defined by the National Government.
Type of policy measure	It is a command and control measure. If farmers do not comply with its requirements their direct payments are reduced or eliminated. This measure combines decoupled direct payments and the compulsory compliance with environmental standards.
Objective of policy measure and relevance	The objective is to include environmental considerations into the CAP by integrating a decoupled single payment with environmental protection, animal welfare, and food and animal feed security into the CAP.

	Apart form the statutory management requirements, the National Government defined the minimum requirements for Good Agricultural and Environmental Conditions on the basis of the common framework set up in Annex IV that covers four issues, namely: Protecting soil from erosion, Maintaining soil organic matter, Maintaining soil structure, and Ensuring a minimum level of maintenance and avoiding deterioration of habitats.
	How relevant are the objectives of the measure to the soil degradation threats in your region? □ □ X □ □ Not very Very
Indirect effects	For some small and marginal farms that rely on agricultural subsidies, the new requirements in this scheme may not compensate the payment that they were already receiving, what may cause some land abandonment.
Linkages to other policy measures	The regulation is linked to many other regulations. The statutory management rules are based on 18 Community legislative acts in the areas of public, animal and plant health, environment and animal welfare. Five of these Council Directives are related to environment and must be applied as implemented by the National Government before. These five Directives are the Wild Birds Directive (79/409/CEE), the Ground Water Directive (80/68/CEE), the Sewage Sludge Directive (86/278/CEE), the Nitrates Directive (91/676/CEE) and the Natural Habitats Directive (92/43/CEE). The relevance of cross compliance rules is that if farmers do not comply with any of these directives, their direct payments are reduced.
Funding	The measure is funded by the EU in the framework of the Common Market Organisations of the Common Agricultural Policy. It is a measure enclosed within the 2003 CAP reforms.
Summary of assessment and conclusions	Regulation 1782/2003 can be an effective measure for soil conservation. However, it is severely criticised by many stakeholders: Its design does not take into account regional and, more importantly, local conditions; technical requirements are not clearly defined; the administrative costs are very high and would only provide results in the long run.
Recommendation	Regional differences should be considered. Regional governments have participated in establishing the practices or requirements in the cross compliance rules that apply across the country and are not locally adapted. They may also add specific technical requirements for farmers in the region but this was not done.
Part B: Detail on the Measures Design, Implementation, Enforcement and Impacts	
Policy design	The policy is designed by the European Commission and approved by both the European Parliament and the EU Council. Agricultural organisations and environmental NGOs try to influence the design process.
Policy implementation I: Implementation at administrative level	The National Government is responsible for the implementation of this measure. There is some space for flexibility in the implementation process at the national level. The CARM is responsible for the implementation at the regional level. A new authority has been created for the implementation: the Regional Commission

	for the Coordination of Cross Compliance (Comisión Regional de Coordinación para el Control de la Condicionalidad de la Región de Murcia). The Regional Government uses its existing administration and control systems that are compatible with the integrated administration and control system.
Policy implementation II: Method of delivery to farmers	The policy is delivered to the farmer by CARM through the OCAs, the agricultural organisations and other organisations such as the Groups of Livestock Sanitary Defense (Agrupaciones de Defensa Sanitaria Ganaderas). Several organisations, including the regional administration offer trainings and workshops for farmers to raise awareness and understanding of the regulation. Farmers receive help from the OCAs and agricultural organisations to fill out the application forms.
Targeting	Requirements are not regionally or locally adapted. □ X □ □ □ Low High
What Drives Uptake?	Farmers do not want to lose their direct payments and thus comply with the rules outlined in the regulation. X □ □ □ □ Obligation Financial incentive Information & support Exhortation Other
Technical measures	For soil conservation, the cross compliance rules affect directly relevant soil conservation issues: - Crops must be planted as soon as possible in order to avoid soil exposure to eroding factors. - Tillage must follow contour lines in herbaceous crops when slope is over 10 %. - In general, tillage is not allowed in the vineyards, olive groves and nut plantations when the slope is steeper than 15 %, except if terraces exist, conservation tillage is used or a total vegetation cover of soil is kept. - In olive groves with naked soil, the strip roads perpendicular to the slope's direction must maintain some vegetation cover. - The farmland, set-aside and fallow land will be maintained by traditional cultivation practices, minimum tillage or maintenance of an adequate vegetation cover. - The specific restrictions established by the competent authority must be observed in those areas with erosion risk. - The existing terraces, steep banks and ridges must be kept in good condition. - The prohibition of burning stubble fields must still be observed except those officially authorised. - The farmers in those areas with over-exploited aquifers must prove their right to irrigate their farmlands with the adequate document. On the other hand, every owner of privately used water must maintain discharge measurement systems.

Enforcement and control	The compliance with the regulation is controlled jointly by the Farm Subsidies Section of CARM and the Regional Commission for the Coordination of Cross Compliance. The monitoring process includes administrative checks of all applications for direct payments via the Integrated Agricultural Control System (IACS), systematic on-the-farm checks of 1 % of all farms receiving direct payments, and cross checks. The administrative check controls the area affected by the measure, the field notebook that farmers must fill detailing all farm operations, and farm's accountancy. On-the-farm-checks are a field control based on visual observation on the farm and the taking of photographs and measurements. Regarding sanctions, detected cases of infringement lead to a reduction in direct payments up to 100 %, depending on the severity and reiteration of the infringement.
Monitoring and evaluation	The National Government monitors the implementation at the regional level, while the European Commission monitors the implementation of the regulations in each member states.
Outcomes of policy measure	The combination of direct payments with the obligation to comply with environmental requirements results in a change of farmers' behaviour as they make efforts to comply and maintain their current subsidies. The monitoring and control is effective. However, the bureaucratic burden for both the administration and the farmer is excessive.
Analysis of drivers of policy measures' out-comes	The driver of the measure is the combination of the direct payments with the compliance of the requirements.
Part C: Evaluation of the Policy Measure	
Effectiveness of policy measure (in relation to the extent to which objectives are achieved, and cost-effectiveness)	The effectiveness is limited by the difficulties associated with the administrative implementation. The practices required are clearly defined, although they are subject to controversy regarding the adequacy of some aspects. Stakeholders think the measure's cost effectiveness is small.
Constraints to achieving full potential of the policy measure	The reason for the measure's success is the strictness of the regulation and its control. The measure is not effective in more intensive agriculture that is less dependent on subsidies. May be a large burden for small marginal farms, leading to land abandonment and, in absence of effective programmes addressing this issue, further damage to soils.
Reasons for the success of the policy measure (where appro-priate)	

7.2.2 Fiche 2: Agricultural soil conservation/Soil erosion control agri-environmental scheme

Part A: Summary of Measure	
Formal title of measure and date of imple-mentation	Agricultural soil conservation/soil erosion control agri-environmental scheme (AES) in the framework of the Rural Development Plan 2007-2013 of the Murcia region, according to regulation 1698/2005/EC. (Programa agroambiental de conservación de suelos agrícolas/lucha contra la erosión dentro del marco del Plan de Desarrollo Rural 2007-2013), 01/01/2007
Short descrip-tion of the measure	Agri-Environmental Measures are an element of the RDP that finance farmers that voluntarily adopt certain environmental practices to provide greater environmental benefits than those in the Code of GAP or in cross compliance standards (GAEC and SMR). They aim to make agricultural production and environmental conservation compatible (CARM, 2007). The agricultural soil conservation agri-environmental measure has existed since 2000, but has been completely redesigned to make it more effective for the period 2007-2013. This AES ranks fourth in terms of available finance, with 8 % of the budget devoted to it. The first one is the organic agriculture AES (57 %), followed by the integrated production AES (17 %) and the new environmental integration of vineyards AES (12 %). The measure is divided in two sub-measures: one for farm practices and the other for non-productive investments (ditches, terraces, etc.). Farmers agree to comply with the requirements in the measure for a one+five year period (one year for the non-productive investments and five for the conservation practices). There are separate payments for the two sub-measures. Payments increase with farm average slope. The measure also includes the option to voluntary use the grinded remains of pruning operations with an additional payment to cover its costs. It is voluntary because is a relatively new practice that requires specific machinery that is not common in the region. This practice is increasingly being adopted by farmers in Spanish Mediterranean areas, even in flat areas. In some agricultural systems, such as olive, it has been adopted by more than 50 % of farms, especially the largest ones (Franco, 2009).
Type of policy measure	It is an incentive-based measure.
Objective of policy measure and relevance	The measures should make compatible both agricultural production and soil conservation using agricultural techniques targeted at soil conservation and the control of water erosion (CARM, 2007).
	How relevant are the objectives of the measure to the soil degradation threats in your region? ☐ ☐ ☐ ☐ X Not very Very
Indirect effects	Do not exist.

Linkages to other policy measures	The AES measures are linked to the Code of Good Agricultural Practice that must be complied with to be eligible for all Rural Development Plans. The AES requirements are more demanding for the farmers, and provide more environmental benefits, than those in the Code of Good Agricultural Practice.
Funding	As for most measures in the Second Axis of the RDP, 41 % of the scheme is financed by the European Union, 45 % by the Murcia region and 14 % by the Spanish National Government.
Summary of assessment and conclu-sions	This measure has been completely redesigned with respect to the previous one, which gave a relatively small payment in exchange of adopting several practices that were not as demanding as the ones in the new measure. For agricultural officers and academic experts, these were easy to comply with, what made it an attractive programme for farmers, and not as effective as it would be desirable. Practices in the former measure were established at the national level and were too general and not fully adequate for the region. The new measure is more technically complex, offering higher payments in exchange. Payments are discriminated based on slope, i.e. based on the risk of soil erosion and cost of practices and investments. Agricultural organizations criticise that payments are increased if that means that less farmers will be able to benefit from this scheme. In our opinion, it is a measure with a high potential for targeting the soil conservation problems in the mountainous areas of the region. It has being designed at the regional level and with the participation of a working group of renowned soil scientists. The Regional Government has tried to tackle the agricultural soil conservation problem. Other Regional Governments have opted to redesign the soil erosion AES in order to adapt it to their conditions, while others have maintained its former design and still others have eliminated it. The measure is focused on infrastructure works and vegetation cover, and does not consider no-tillage as an option due to the scarce rainfall in the region. Regarding infrastructure, farmers interviewed by Calatrava and Gonzalez (2008) claimed that in the evaluation of applications for subsidies to finance improvements in farm productive structures in the former RDP (e.g. planting new and more profitable tree varieties), most soil conservation and water retention infrastructure were considered non-productive and non-profitable and were not financed. As a totally new measure, it is difficult to evaluate it. One drawback could be the opposition exhibited by agricultural organisations as a whole. Another is that it is somehow unknown for already participating farmers as it is more a new redesigned scheme than a continuation of the previous one. The time will tell whether the measure is successful or not. One issue that has raised a lot of controversy among the Regional Government and agricultural organisations is the upper slope limit to participate in the measure, presently set at 20 %. For the Regional Government, agriculture should not be allowed on land above 20 % slope, and this land should be forested. Farmers claim that the reality is that these farms exist and that the measure neglects farms with high risk of soil erosion. Another main drawback is the limited budget. It is aimed at a maximum of 400 farms and 8,000 hectares in the whole region.

Recommendation	A suggestion from academic/research stakeholders is that some analysis of the potential for adoption should have been done to improve the measure's design. The interviewees also claim that a drastic redesign of the measure can be positive but also sends signals to farmers that policies do not have continuity what may cause disincentives to participate.
Part B: Detail on the Measures Design, Implementation, Enforcement and Impacts	
Policy design	The prescriptions for individual measures of the agri-environmental scheme are designed by the Agriculture Department of the Murcia Regional Government. Agricultural organisations and academic experts are consulted but do not have a great capacity to influence the design.
Policy implementation I: Implementation at administrative level	AES are implemented and monitored by the Regional Government and undertaken through the local district agricultural extension agencies (OCA). Agricultural organisations play a very important role in helping farmers with the administrative burden of the AES measures, and also as the advisory services in the area.
Policy implementation II: Method of delivery to farmers	The policy is delivered to the farmer by CARM through the OCAs and the agricultural organisations. Farmers receive help from the OCAs and agricultural organisations to fill out the application forms.
Targeting	The measure applies to all farms in the region that comply with the administrative requirements (size, slope, etc), but establishes a ranking of areas in terms of soil degradation risk. Part of the area of study is on the high risk areas and the rest in the medium risk areas. □ □ □ X □ Low High
What Drives Uptake?	Financial incentives are the main reason for farmers to take part in AES. It can be expected that some farmers would also apply measures without payments and that other participate in the AES because they were already doing the required practices. □ X □ □ □ Obligation Financial incentive Information & support Exhortation Other
Technical measures	The technical requirements of the new soil erosion AES designed by the Regional Government have drastically changed compared to the previous scheme designed by the National Government. In the previous scheme, apart from administrative requirements, the specific practices required were: maintaining vegetation layers on the borders of farm plots; maintaining hedges, stonewalls and terraces; prohibition of certain types of ploughing and the use of heavy machinery; maintaining vegetation covers in a minimum of 50 % of the area in plots with more than 10 % slope; and prohibition of chemical pruning techniques. In the new measure the required practices are: - Not only maintaining, but also building infrastructure works related to soil conservation and water retention (ponds, ditches, trenches, stone terraces).

	- Prohibition of tillage following slope line, regardless of the slope. - Establishing permanent vegetation strips in land with soil erosion problems, with a minimum of a 25 % of its area with some of the re-vegetation species indicated and a maximum of a 75 % planted with cereals and protein crops that could neither be harvested nor pastured. - In parcels crossed by water flows, a fringe of 3 to 5 meters wide should be maintain without crops and re-vegetation species should be planted at both sides of the riverbed.
Enforcement and control	Compliance with the measure is controlled by CARM. The control process includes administrative checks of all applications of payments for the AES via the Integrated Agricultural Control System (IACS) and on-the-farm checks of 5 % of all farms receiving AES payments based on a specific risk analysis. The administrative check controls the area affected by the measure, the field notebook that farmers must fill detailing all farm operations, and farm's accountancy. On-the-farm checks are a field control based on visual observation on the farm and the taking of photographs and measurements. Infringement of requirements leads to rejection of the application, reduction of payments, or the (partial) recall of the payments. Further controls are conducted directly by the European Commission.
Monitoring and evaluation	Different monitoring mechanisms are in place for AES: Ex-ante evaluation, midterm evaluation and ex-post evaluation. The evaluation of the 2000-2006 AES measures can be found in the Murcia Region RDP 2007-2013.
Outcomes of policy measure	The measure is aimed at achieving a great level of soil conservation in those areas with greater risk of soil erosion. 25 % of the area participating in the measures should be in Nature 2000 areas, aiming to a total of more than 20 % of the area covered by vegetation strips.
Analysis of drivers of policy measures' out-comes	Reasons for enrolling in the scheme are financial incentives provided by the scheme to compensate for the economic losses, mostly derived from water competition from vegetation, as well as moral persuasion to conserve soils and the environment.
Part C: Evaluation of the Policy Measure	
Effectiveness of policy measure (in relation to the extent to which objectives are achieved, and cost-effectiveness)	The programme is new and it is difficult to assess its effectiveness. The previous scheme was fairly popular, although payments were mean, because the requirements were perceived as easy to adopt. Stakeholders do not think it was as environmentally effective as desirable. This programme is more complex but better targeted, and its implementation costs are similar to the previous one. However, as it aims for greater environmental benefits through greater payments, it is difficult to assess if its cost effectiveness will be improved in terms of reducing soil erosion. Administration officers and some academic stakeholders believe it will. Agricultural organisations disagree. It must also be taken into account that building new infrastructures for soil erosion and water retention will also have a positive effect for society as a whole in an area where flash floods are frequent and intense, and where landslides are not unusual.

Constraints to achieving full potential of the policy measure	Constraints are financial restrictions that limit excessively the potential of the measure in terms of area affected, as well as the administrative burden of the AES measures, perceived by farmers as an important drawback.
Reasons for the success of the policy measure (where appro-priate)	Not applicable.

7.2.3 Fiche 3: Organic Agriculture agri-environmental scheme

Part A: Summary of Measure	
Formal title of measure and date of imple-mentation	Organic agriculture agri-environmental scheme (AES) in the framework of the Rural Development Plan 2007-2013 of the Murcia region, according to regulation 1698/2005/EC. (Programa agroambiental de agricultura ecológica dentro del marco del Plan de Desarrollo Rural 2007-2013), 01/01/2007
Short descrip-tion of the measure	Agri-environmental measures are an element of the RDP that finance farmers that voluntarily adopt certain environmental practices to provide greater environmental benefits than those in the Code of GAP or in the cross compliance standards (GAEC and SMR). They aim to make agricultural production and environmental conservation compatible (CARM, 2007). The organic agriculture agri-environmental measure has existed in Spain since the beginning of AES in 1992. The implementation in Murcia started in 2001, and it included every crop except rice. The measure for the period 2007-2013 is similar to the one in the previous RDP period. The measure is based on the rules contained in Regulation 2092/91/EEC that regulates organic farming, and complemented by some additional specific requirements set by the Regional Council to Regulate Organic Agriculture (Consejo de Agricultura Ecológica de la Región de Murcia, CAERM). Farmers agree to comply with the requirements in the measure for a five year period. Payments are different for each crop from the lower (extensive herbaceous crops) to the highest (fruit trees). Open-air horticulture, greenhouse production and tomato are not financed.
Type of policy measure	It is an incentive-based measure.
Objective of policy measure and relevance	The measure aims to preserve ecosystems, maintaining or increasing soil fertility and organic matter content, obtaining crops free of chemical residues and reducing chemical pollution from agricultural sources (CARM, 2007).
	How relevant are the objectives of the measure to the soil degradation threats in your region? □ □ □ X □ Not very Very
Indirect effects	Do not exist.

Linkages to other policy measures	The AES measures are linked to the Code of Good Agricultural Practice that must be complied with to be eligible for all Rural Development Plans. The AES requirements are more demanding for the farmers, and provide more environmental benefits, than those in the Code of Good Agricultural Practice
Funding	As for most measures in the Second Axis of the RDP, 41 % of the scheme is financed by the European Union, 45 % by the Murcia region and 14 % by the Spanish National Government.
Summary of assessment and conclu-sions	This measure is similar to the previous organic agriculture AES designed by the National Government, with the addition of some technical requirements set by CAERM. Most stakeholders evaluate this measure positively, and consider it the most relevant one to reduce the soil degradation problems in irrigated agriculture. Apart from the general request for more funding for this measure, agricultural organisations claim that it is a fairly popular measure but the limited administrative capacity of the Regional Government and the excessive requirements makes participation very difficult for farmers. In our opinion, it is a measure with a good potential for targeting the soil degradation problems in the region, being one of the most relevant for the irrigated areas. A majority of farmers following organic principles, or at least integrated production principles, should be a priority for the Regional Government. The measure has continuity over time, and is adapted to regional conditions. We see as the main problem that compensation payments are calculated on the basis of the absolute increase in costs and the decrease in revenues. For intensive agriculture, where environmental impacts are greater, although payments are greater in absolute terms, they may be smaller in relative terms with respect to farm profit. This could cause that the majority of farms in the programme to grow crops that are more easily transformed into organic production. In fact, 90 % of the area under organic production in the region is planted with (in order of importance) extensive herbaceous crops and aromatic plants, almond trees, vineyards and olive trees (data in the RDP, CARM, 2007). It is aimed at a maximum of 1,500 farms and 30,000 hectares in the whole region, which is more than the total area under organic production in 2006 (CARM, 2007). It is the most important AES as 57 % of the budget is devoted to it.
Recommenda-tion	A suggestion from most stakeholders is that funding for this measure should be a priority, although they insisted that this programme in isolation is not effective to incentivise the diffusion of organic agriculture among farmers. A positive feature is the continuity of the programme over time.
Part B: Detail on the Measures Design, Implementation, Enforcement and Impacts	
Policy design	The prescriptions for individual measures of the agri-environmental scheme are designed by the Agriculture Department of the Murcia Regional Government. Agricultural organisations and academic experts are consulted but do not have a great capacity to influence the design. In the case of organic agriculture, a Regional Council to Regulate Organic Agriculture (Consejo de Agricultura Ecológica de la Región de Murcia, CAERM) was created several years ago.

Policy implementation I: Implementation at administrative level	AES are implemented and monitored by the Regional Government and undertaken through the local district agricultural extension agencies (OCA). Agricultural organisations play a very important role in helping farmers with the administrative burden of the AES measures, and also as the advisory services in the area.
Policy implementation II: Method of delivery to farmers	The policy is delivered to the farmer by CARM through the OCAs and the agricultural organisations. Farmers receive help from the OCAs and agricultural organisations to fill out the application forms.
Targeting	The measure applies to all farms in the region that comply with the administrative requirements. □ □ □ X □ Low High
What Drives Uptake?	Financial incentives are the main reason for farmers to take part in AES. It can be expected that some farmers would also apply measures without payments and that other participate in the AES because they were already doing the required practices. □ X □ □ □ Obligation Financial incentive Information & support Exhortation Other
Technical measures	In a simplified manner, the requirements are: - The farmer must be registered as an organic farmer by CAERM. - To strictly comply with the production rules established by Regulation 2092/91/EEC that regulates organic farming - To comply with the rules set by the CCAE in those issues not regulated by the above mentioned regulation, especially in those issues related with fertilisation, pest control and weeds control. - Technical direction of the farm by an agricultural engineer is compulsory - Produce must be marketed as organically produced. - Hydroponic production systems are prohibited. - Prohibition of using GMOs in seeds, plant treatments, etc.
Enforcement and control	Compliance with the measure is controlled by the CARM. The control process includes administrative checks of all applications of payments for the AES via the Integrated Agricultural Control System (IACS) and on-the-farm checks of 5 % of all farms receiving AES payments based on a specific risk analysis. The administrative check controls the area affected by the measure, the field notebook that farmers must fill detailing all farm operations, farm's accountancy, the certification by a competent agricultural technician and the certification from CAERM. On-the-farm checks are a field control based on visual observation on the farm, taking photographs and measurements; inspecting both farm machinery and the warehouse where plant treatment products are stored; and taking samples for the analysis of residuals. Infringement of requirements leads to rejection of the application, reduction of payments, or the (partial) recall of the payments. Further controls are conducted directly by the European Commission.

Monitoring and evaluation	Different monitoring mechanisms are in place for AES: Ex-ante evaluation, midterm evaluation and ex-post evaluation. The evaluation of the 2000-2006 AES measures can be found in the Murcia Region RDP 2007-2013.
Outcomes of policy measure	The measure aims for a 25 % increase in the area under organic farming in the region, with 35 % of the area participating in the measure located in Nature 2000 areas.
Analysis of drivers of policy measures' out-comes	Reasons for enrolling in the scheme are financial incentives provided by the scheme to compensate for the economic losses derived from the reduction in yields, as well as moral persuasion to conserve soils and the environment. However, CARM assumes that the increased market price for organic products partially offsets the reduction in yields and payments are subject to a 20 % reduction in the last two years of the programme.
Part C: Evaluation of the Policy Measure	
Effectiveness of policy measure (in relation to the extent to which objectives are achieved, and cost-effectiveness)	The programme is fairly popular among farmers, although most participants are into organic farming prior to participating in this AES. There is a wide agreement on the scheme's benefits and the only criticism regards the limited funding and administrative difficulties related to inspections and the processing of applications. Stakeholders perceive the scheme as having a good level of cost-effectiveness but think it would render more in combination with other measures (such as generic promotion of organic products and lifestyles, subsidies for technical advisors and marketing channels and increase in the funding of organic-oriented agricultural research).
Constraints to achieving full potential of the policy measure	Constraints are financial restrictions that limit excessively the potential of the measure in terms of area affected, as well as the administrative burden of the AES measures, perceived by farmers as an important drawback.
Reasons for the success of the policy measure (where appro-priate)	It is a well known and attractive measure for farmers, and its importance assures continuity in the future. It is well adapted for regional conditions. In its current design it is very attractive for non-irrigated and less profitable crops and farms, that already receive other EU subsidies (Single Payment Scheme, other RDP measures), and that have relatively low costs of converting to organic farming.

7.2.4 Fiche 4: Integrated production agri-environmental scheme

Part A: Summary of Measure	
Formal title of measure and date of imple-mentation	Integrated production agri-environmental scheme (AES) in the framework of the Rural Development Plan 2007-2013 of the Murcia region, according to regulation 1698/2005/EC. (Programa agroambiental de producción integrada dentro del marco del Plan de Desarrollo Rural 2007-2013, 01/01/2007)
Short descrip-tion of the measure	Agri-environmental measures are an element of the RDP that finance farmers that voluntarily adopt certain environmental practices to provide greater environmental benefits than those in the Code of GAP or in the cross compliance standards (GAEC and SMR). They aim to make agricultural production and environmental conservation compatible (CARM, 2007).

	The Integrated Production Scheme in Murcia started in 2001. The measure for the period 2007-2013 is similar to the one in the previous RDP period. In the 2000-2006 RDP there were three AES providing incentives for the adoption of environmental techniques for the rational use of chemicals, including cultivation techniques to reduce the polluting effects on soil and water, namely the Organic Agriculture AES, the Integrated Production AES and the Integrated Control of Phyto-sanitarium Treatments Scheme. The former AES has disappeared in the new RDP 2007-2013. This was a popular measure as many of the beneficiaries were previously farming according to Integrated Production as defined by a previous regional regulation that was less strict than the requirements in the 2000-2006 AES. As they could not comply with the new requirements they opted for the Integrated Control of phyto-sanitarium treatments instead, which was considered by farmers, technical advisors and Professional Organisations as easier to adopt (Rojo, 2004). The requirements in the 2000-2006 Integrated Production AES were not fully adequate for the characteristics of the regional agriculture. With changes in the technical rules, the Regional Government has now opted to foster Integrated Agriculture. Farmers agree to comply with the requirements in the measure for a five year period. Payments are different for each crop from the lower (non-irrigated almond) to the highest (fruit trees, open-air horticulture and greenhouse production). Extensive herbaceous crops are excluded from this measure. Compensation payments are much lower than those in the Organic Agriculture AES. Farmers must be registered in the Register of Producers and Operators of Integrated Production of the Murcia Region (Registro de Productores y Operadores de Producción Integrada de la Región de Murcia, RPOPIRM).
Type of policy measure	It is an incentive-based measure.
Objective of policy measure and relevance	The measure aims to preserve ecosystems and biodiversity, recovering and/or maintaining soil fertility and organic matter content, obtaining crops with less chemical residues, and reducing chemical pollution from agricultural sources in air, water and soils (CARM, 2007).
	How relevant are the objectives of the measure to the soil degradation threats in your region? □ □ □ X □ Not very Very
Indirect effects	Do not exist.
Linkages to other policy measures	The AES measures are linked to the Code of Good Agricultural Practice that must be complied with to be eligible for all Rural Development Plans. The AES requirements are more demanding for the farmers, and provide more environmental benefits, than those in the Code of Good Agricultural Practice
Funding	As for most measures in the Second Axis of the RDP, 41 % of the scheme is financed by the European Union, 45 % by the Murcia region and 14 % by the Spanish National Government.

Summary of assessment and conclusions	This measure is similar to the previous Integrated Production AES designed by the National Government that was also based on the regional rules for Integrated Production, but these have been better adapted to regional conditions. Most stakeholders make a very positive evaluation of this measure, and consider it relevant to reduce the soil degradation problems in intensive irrigated agriculture. It is likely to become increasingly popular after the closure of the Integrated Control of Phyto-sanitary Treatments Scheme. In our opinion, it is a measure with a good potential for targeting the soil degradation problems in the region, being one of the most relevant for the irrigated areas. Organic farming is the priority for the Regional Government and for most stakeholders, but integrated production is good alternative for crops and areas in which organic farming is too difficult and/or costly to adopt. It is relevant in those parts of the case study area where tomato and greenhouse production is important. Furthermore, in some cases Integrated Production constitutes a transition between conventional and organic farming for farmers, serving as a period of training and gradual transformation for the farmer towards more environmentally-friendly techniques. It also has continuity over time, and is adapted to regional conditions. It is aimed at a maximum of 1,500 farms and 12,000 hectares in the whole region. It is the second most important AES with 17 % of the AES budget devoted to it, after the Organic Agriculture AES with 57 %.
Recommendation	This measure is less known to famers than the Organic Agriculture AES. More information should be given to farmers as it can be a good alternative for crops and areas in which organic farming is too difficult and/or costly to adopt. It can also have positive synergies with the organic agriculture AES. It should be maintained and fostered in the future.
Part B: Detail on the Measures Design, Implementation, Enforcement and Impacts	
Policy design	The prescriptions for individual measures of the agri-environmental scheme are designed by the Agriculture Department of the Murcia Regional Government. Agricultural organisations and academic experts are consulted but do not have a great capacity to influence the design.
Policy implementation I: Implementation at administrative level	AES are implemented and monitored by the Regional Government and undertaken through the local district agricultural extension agencies (OCA). Agricultural organisations play a very important role in helping farmers with the administrative burden of the AES measures, and also as the advisory services in the area.
Policy implementation II: Method of delivery to farmers	The policy is delivered to the farmer by CARM through the OCAs and the agricultural organisations, mainly cooperatives. Farmers receive help from the OCAs and agricultural organisations to fill out the application forms.
Targeting	The measure applies to all farms in the region that comply with the administrative requirements. □ □ X □ □ Low High

What Drives Uptake?	Financial incentives are the main reason for farmers to take part in AES. It can be expected that some farmers would also apply measures without payments and that other participate in the AES because they were already doing the required practices. □ X □ □ □ Obligation Financial incentive Information & support Exhortation Other
Technical measures	In a simplified manner, the requirements are: - Reduction in chemicals plant treatments for pest control, giving priority to the use of biological, physical or cultural methods (predators, parasites, captures, pheromones traps, etc.) instead of chemical methods. - Farmer must be registered as integrated producer by the RPOPIRM. - To comply with the technical rules for Integrated Production set by the RPOPIRM. Only chemical products authorised by RPOPIRM may be used. - Technical direction of the farm by an agricultural engineer is compulsory - Produce must be marketed as Integrated Production. - Hydroponic production systems are prohibited. - Prohibition of using GMOs in seeds, plant treatments, etc.
Enforcement and control	Compliance with the measure is controlled by CARM. The control process includes administrative checks of all applications of payments for the AES via the Integrated Agricultural Control System (IACS) and on-the-farm checks of 5 % of all farms receiving AES payments based on a specific risk analysis. The administrative check controls the area affected by the measure, the field notebook that farmers must fill detailing all farm operations, farm's accountancy, the certification by a competent agricultural technician and the certification from the CAERM and the control entity. On-the-farm checks are a field control based on visual observation on the farm, taking photographs and measurements; inspecting both farm machinery and the warehouse where plant treatment products are stored; and taking samples for the analysis of chemical residuals. Infringement of requirements leads to rejection of the application, reduction of payments, or the (partial) recall of the payments. Further controls are conducted directly by the European Commission.
Monitoring and evaluation	Different monitoring mechanisms are in place for AES: Ex-ante evaluation, midterm evaluation and ex-post evaluation. The evaluation of the 2000-2006 AES measures can be found in the Murcia Region RDP 2007-2013.
Outcomes of policy measure	The measure aims to increase in the area under integrated production in the region, with a third of the area participating in the measure located in Nature 2000 areas.
Analysis of drivers of policy measures' out-comes	Reasons for enrolling in the scheme are financial incentives provided by the scheme to compensate for the economic losses derived from the reduction in yields and the increase in costs, as well as moral persuasion to conserve soils and the environment.
Part C: Evaluation of the Policy Measure	
Effectiveness	The programme was not very popular for the reasons commented in the

of policy measure (in relation to the extent to which objectives are achieved, and cost-effectiveness)	"Summary of assessment and conclusions" section above. Some agricultural stakeholders criticise the previous technical design and ask for more information to be given to famers. However, its limited success in the past makes difficult to assess its effectiveness.
Constraints to achieving full potential of the policy measure	Constraints are financial restrictions that limit excessively the potential of the measure in terms of area affected, as well as the administrative burden of the AES measures, perceived by farmers as an important drawback.
Reasons for the success of the policy measure (where appro-priate)	Although it is not as popular as the Organic Agriculture AES and the now closed Integrated Control Scheme, it can be expected that famers who have participated in the previous scheme will now enter the Integrated production AES. It can be a good alternative for crops and areas in which organic farming is too difficult and/or costly to adopt.

7.3 Summary of policy use and effectiveness

One important conclusion is that a consistent agricultural soil conservation policy does not exist. Most interviewees coincide in that several policy measures with some soil conservation objectives exist. In some cases, these measures directly aim at soil conservation but in other cases it is a secondary objective or simply an outcome of addressing other issues.

Soil conservation is perceived as a serious problem but it is not among the main priorities for farmers and agricultural organisations. In terms of priorities, soil conservation stands after other issues such as water resources or market and price issues. For administration officers, soil conservation is given the same importance as other environmental problems but no more. The majority of agri-environmental measures have an important soil conservation content in the new RDP. However, all policy initiatives are applications of EU policies, and no original measures are developed at national or regional level. In this sense, the recently passed National Action Program to fight against desertification (August 2008) does not add anything new to agricultural soil conservation, as it aims to integrate soil conservation into agricultural and environmental policy making, but neither includes new measure nor additional funding. Stakeholders do not expect new and effective policies to be developed. Some academic interviewees hope that the future EU Soil Framework Directive will increase the available funding for soil conservation, but do not expect this to result in new and more effective measures.

For a majority of stakeholders, the most effective policies aimed at soil conservation are several agri-enviromental schemes and the single payment scheme, although criticisms to their design are numerous.

Agri-environmental Schemes are the most relevant policy for the stakeholders interviewed. Respondents are quite in favour of AES and highlight it as the most relevant policy: it provides environmental benefits and is well received by farmers.

Most respondents think that the most important AES for soil conservation are the AES for soil erosion control, the AES for organic production, and the AES for integrated production one. The other AES have a marginal effect on soil conservation.

Most respondents, for different reasons, state that the former soil erosion AES (2000-2006), which was designed by the National Government, was not very well designed to provide environmental benefits, was not locally adopted, although it was technically viable, and was

even unknown to many farmers. They think its impact was reduced. Academic stakeholders claim that the AES approach ignores other factors that affect the adoption of conservation practices, such as farm size, farmer's age, farm profitability, continuity of relatives in farming, etc. They also think that requirements and payments should be different for, or even focus exclusively on, land with a higher risk of soil degradation and that AES should be complemented with farm modernisation programmes and other RDP.

In this sense, the new soil erosion AES designed by the regional administration is perceived by its officers as better designed and with greater potential to provide environmental benefits. It focuses on areas where the risk of soil erosion is greater and therefore potential environmental benefits are greater, offering greater per hectare payments and increasing payments with farm slope. Agricultural organisations disagree with this design as they think it will reach only to a small number of farmers.

Regarding the Organic Agriculture AES, the Integrated Production AES and the closed Integrated Pest Management AES, most respondents make a very positive evaluation of them. Agricultural organisations agree but claim that the administrative capacity and the excessive requirements make participation very difficult for farmers, especially in the Organic Agriculture AES.

Apart from design problems, effectiveness of AES measures is reduced by the lack of funds that restricts the extent of hectares under contract. Agricultural organisations claim that the Regional Government lacks administrative capacity and delays payments for most AES, and that result in the loss of EU and national funds and makes the AES ineffective.

However, AES are well designed to target regional soil conservation problems, and are popular among famers, although some of them are not as well known by farmers as it would be desirable.

The **Single Payment** Scheme is usually regarded as an instrument with a great potential to integrate environmental concerns into agricultural policy and to stress the enforcement of previously existing regulations (Baldock and Mitchell, 1995). Unquestionably, cross compliance is a valuable scheme to provide strong incentives for the adoption of environmentally sound farming activities. Surprisingly, stakeholders in the case study area perceive this potential only in the theoretical world and are critical to the current design of this measure.

In general, stakeholders think that practices required can be technically adopted by most farmers, but also that transaction costs are quite large. The scheme as it is currently designed is perceived by most respondents as complicated, difficult to understand for farmers, difficult to monitor, not locally adapted, and of little environmental effectiveness. Administration officers think that cross compliance, as it is designed, is more a voluntary measure than a compulsory one. Interviewees from agricultural organisations think that the Single Payment Scheme creates disloyal and unfair competition between those farmers that have right to the Single Payment and those that do not. They perceived as unfair that some farmers may receive a direct payment and other do not. They are also concerned about other regions where subsidised crops are competing with the local produces and are causing farmers to shift their productions in order to secure income from the Single Payment.

Several respondents think that the costs of practices required are affordable for large, profitable and professional farms, but not for small ones. These costs are greater for part-time and small farmers, and may not be compensated by the amount of their single payment. In general, stakeholders perceive that cross compliance requirements are easier to comply with on land where marginal social benefits of soil conservation are smaller.

Similarly, there is a widespread perception among stakeholders of the excessive administrative burden associated with the Single Payment Scheme that may stem form the necessary implementation and control system of this scheme, in line with the views of Whitby et al. (1998) and Varela-Ortega et al. (2002).

Apart from the above, this measure barely affects irrigated agriculture in the area and may increase the risk of land abandonment in rainfed agriculture areas, what raises the importance of forestation schemes and other RDP.

Regarding the **Forestation of agricultural lands** measure, administration officers agree in its effectiveness and highlight its adequate technical design and successful implementation. For them, it is technically well designed, effective and well implemented. Their view is that farmers forest their lower-yield parcels and receive a complementary income. Interviewees from agricultural organisations disagree with this policy and think it is not at all effective, it that encourages land abandonment and that its benefits are only apparent in the long run. As the rest of stakeholders, research/academic interviewees think that environmental benefits of this measure lie in long-term benefits and that this is not a relevant measure for the conservation of agricultural soils, but they highlight its importance to reduce the environmental impacts of land abandonment.

Regarding the **nitrate pollution control** policy measures, most interviewees think that the existing policies for nitrate pollution control are not adequate for irrigated agriculture in the area. The area is not declared as Nitrate Vulnerable Zone. However, most respondents think it should be a NVZ, partly for precautionary reasons before the problem gets worse. The Nitrates Directive is considered difficult to implement in the area, and not really adequate for the area[13]. In addition, the Single Payment Scheme is not relevant in irrigated agriculture and therefore cross compliance rules cannot be relied upon to ensure the implementation of the Nitrates Directive. Apart from that, responsibilities on discharges to water bodies and water quality are divided between the Regional Department of Environment, the River Basin Authority and the town councils.

In irrigated agriculture, the opportunity costs of reduction in fertiliser use are large, and farmers do not find it a relevant environmental problem. First, while pesticides are regarded as poisonous there is no negative perception of fertilisers, a result also found by Izcara-Palacios (2000) in the greenhouse areas of the neighbouring Almería province. Second, the lack of rain in the area reduces the percolation. Third, drip irrigation techniques are widespread in the area and farmers think that nitrogen percolation can be largely reduced using drip irrigation techniques. In rainfed irrigation, nitrate pollution is considered as a non-existing problem. For many stakeholders, concentrating efforts in fostering organic farming, integrated control and drip irrigation technologies would be more cost-effective than trying to comply with the Nitrates Directive.

Many stakeholders highlight the **importance of other policies**. Several interviewees stated that agricultural policies are of little effectiveness in the study area without major changes in other policies. For instance, in the valley area there is a need for sustainable land planning policies to limit urban sprawl and certain crops and agricultural activities. In the highlands there is a need for more effective RDP and structural policies to increase agricultural income and to stop land abandonment, to develop alternative and sustainable agricultural and rural activities, to increase rural population and to limit urban sprawl. Several respondents claim that AES payments should be linked to participation in other RDPs and should be linked to the local population and not to non-resident land owners. In general, most interviewees pointed out the importance of the generational relieve. Younger farmers are most open to sustainable agricultural practices. All this would lead to a greater level of adoption of soil conservation practices.

[13] When the Nitrate Directive (91/676EEC) was passed in 91, the Spanish authorities viewed it as an imposition from northern member States that made no sense in the Mediterranean countries (Izcara-Palacios, 2000). In fact, the law implementing it at the national level was delayed 5 years and only passed after serious and continuous warnings from the EU.

8 Conclusions

Currently, measures for agricultural soil conservation are based both on voluntary and compulsory approaches. First, compulsory measures, such as the Plant Protection Products Directive and the Sewage Sludge Directive have been generally complied with for a long time. Sanctions for non-compliance are important and enforcement has improved over time. The Nitrates Directive is not widely applied in the area. Although this Directive is commonly perceived as not adequate for Mediterranean areas, the declaration of the Guadalentín as a NVZ along with the practical implementation of the WFD could have a positive effect on the reduction of pollution. However, stakeholders considered any of these policies to be of great relevance in terms of providing further soil conservation, and none was named among the three more important ones. They are more perceived as reducing hazards and impacts for water resources and also human beings than improving soil conservation.

Second, voluntary incentive-based measures, such as agri-environmental schemes and the Single Payment Scheme, although the latter is considered by farmers and agricultural organisations as compulsory rather than voluntary, are considered as the more relevant. These aim to promote farming practices that go beyond compulsory practices and provide greater environmental benefits. The relevance of AES has increased after the new RDP as it was designed by the Regional Government and they are now better targeted at regional agricultural soil degradation problems. The agricultural soil conservation/soil erosion control AES in perceived as the best measure for mountainous areas, while for irrigated areas the stakeholders point at organic farming and integrated production AES. Cross compliance rules associated with the Single Payment Scheme are perceived by most stakeholders to be relevant but poorly designed, difficult to implement, and not very effective to mitigate regional soil erosion problems. It has provided some improvements in soil conservation in areas with high dependence on agricultural subsidies but the potential to provide further environmental benefits is low, and it is not relevant in irrigated areas where the level of agricultural subsidies is insignificant.

Although it is not a stand-alone measure but a requirement in others, the Code of Good Farming Practices that must be complied with to participate in any measure in the Rural Development Programmes has resulted in an increase in several basic conservation practices. It is more positively perceived than the cross compliance GAEC standards. The reason seems to be that the Code of GFP was usually associated with other voluntary measures that already required certain practices, thus GFP was perceived as voluntary. On the other hand, cross compliance is perceived as tightening the preconditions for a subsidy that was previously received and that farmers and agricultural organisations perceive as a legitimate right.

We now summarise the positions of stakeholders towards current policies. First, both farmers and their different representative organisations and the administration are clearly in favour of improving existing policies in the sense of simplifying them, making them more locally adapted and providing more economic incentives, something that to some extent is shared by other stakeholders. Both groups also stress the importance of technical education among farmers and their technical advisors. However, they disagree regarding the administrative capacity and the targeting of some policies such as the soil conservation AES. Agricultural organisations also claim for more technical research, oriented to lowering production costs and environmental impacts.

Academic stakeholders from universities and research centres are more critical of current policies. In line with agricultural organisations, academic actors think that the existing policies are not completely well designed to meet soil conservation objectives but rather administrative and economic ones, and that policies are very general, far from reality, and therefore of limited effectiveness. However, only one out of three academic interviewees was familiar with the new measures in the 2007-2013 RDP.

Some academic stakeholders coincide with environmental NGOs in that there is not enough political willingness to solve the problem, there is a lack of sense of governance of the problem, and most programmes are not relevant to solve it. They claim for more radical approaches (CPOs, increase in sanctions, etc.), less bureaucratic programmes and greater involvement of environmental NGOs in the agricultural policy process.

For academic stakeholders and administration officers there is no real agricultural soil conservation policy, but isolated measures that have some main or secondary soil conservation objective. They ask for a greater integration of agricultural, agri-environmental, environmental and rural development policies.

Academic stakeholders point out that in many cases the marginal costs of soil conservation are greater where potential benefits are greater. In this sense, they claim that requirements and payments should be different for, or even focus exclusively in, lands with a higher risk of soil degradation (as has been done in the new 2007-2013 regional soil erosion AES by discriminating areas and farm slope). To achieve this, measures aimed at soil conservation should be complemented with farm modernisation programmes and other RDP.

All interviewees highlighted the importance of distributing more information and convincing farmers and their technical advisors of the importance of soil conservation, through a mix of moral persuasion and technical demonstrations, and encouraging the young population to enter farming. Information could be a more cost-effective measure. They also think that environmental practices should be communicated to the consumer through quality control systems in order to convince farmers of the benefits of environmentally friendly production and organic agriculture.

Apart from the existing policies there exist other farming and soil conservation practices that some farmers have been applying, sometimes since before EU policies were applied in Spain, and without any economic incentive being provided. The reasons for their adoption were multiple: reducing costs, increasing organic matter content to increase yields or simply conserving their soil in the long run. Terraces with or without vegetation or stone cover, hedges, tillage following contour lines, etc. have been traditionally applied by many farmers before they were included as requirements in any policy measure. Even in irrigated intensive horticulture areas crop rotations with cereals or legumes have been common. More recently, a minority of farmers has started to apply no tillage, a practice that is not included in any policy measure, although the climatic conditions of the area are not favourable to it. During the last decade approximately 5 % of farmers in the area have adopted the practice of mulching using the grinded remains of pruning operations (Calatrava and Gonzalez, 2008), a practice that has just recently being introduced in the soil erosion AES, although as a voluntary addition to the measure's main requirements. Another unrelated practice, but that has positive outcomes in terms of reducing input use and deep percolation of nitrogen, is the widespread adoption of water saving irrigation technologies, although its main driver is not soil conservation but water scarcity and economic profitability. Water saving irrigation technologies are partly subsidised under the RDP, although the technologies were adopted by many farmers before subsidies existed. However, according to some interviewed soil experts, the most effective soil conservation practices, namely, maintaining vegetation covers or strips, has rarely been implemented in the case study area, mostly because of vegetation competition for water in a drought prone area. Vegetation covers are one of the main focus of the new agricultural soil conservation AES.

None of the current policies adequately addresses soil problems in the case study area. Even those that include more technical measures, such as the Single Payment Scheme or the soil erosion AES, are only relevant for some types of agriculture and /or soil degradation problems. Some stakeholders point out that it is not logical to try to design one single measure to face all degradation problems, but to develop a full set of different schemes, both compulsory and voluntary, that cover the whole range of agricultural systems and degradation problems in the area. Compulsory practices must be maintained to ensure a

minimum level of conservation, although stakeholders are mostly in favour of voluntary approaches.

Although it is too early to assess the success of the new AES for the period 2007-2013, it is true that compared with the previous period most schemes are now better tailored to the regional problems. In fact, soil conservation is the main objective in one measure and a secondary objective in most measures. Similar flexibility to adapt other EU and national regulations, such as the GAEC standards in the Single Payment Scheme, to local conditions would be desirable.

Another issue that found agreement among stakeholders is the limited funding for the policy measures and for their implementation. Several stakeholders agree in moving more financial resources from CAP Pillar 1 to CAP Pillar 2. Others suggested increasing subsidies to farmers through tax exemptions for those participating in AES and other voluntary schemes.

There is also some space for improvement at the regional policy level. For instance, the implementation of the soil erosion AES was delayed for several years for administrative reasons and farmers also complained about the lack of information during the first stages of the implementation of the Single Payment Scheme. In addition to that, there is not a single authority in charge of all policies related to soil degradation and desertification, but responsibility is shared by several departments of two different bodies of the Regional Government.

References

Alías, L.J., López-Bermúdez, F., Marín-Sanleandro, P., Romero-Díaz, M.A. and Martínez, J. (1997): Clay minerals and soil fertility loss on Petric calcisol under a semiarid Mediterranean environment. *Soil Technology* 10, pp. 9-19.

Álvaro-Fuentes, J., López, M.V., Cantero-Martinez, C. and Arrúe, J.L. (2008): Tillage effects on soil organic carbon fractions in Mediterranean dryland agroecosystems. *Soil Science Society of America Journal* 72, pp. 541-547.

Baldock, D. and Mitchell, K. (1995): Cross-Compliance within the Common Agricultural Policy: A review of options for landscape and nature conservation. Institute for European Environmental Policy (IEEP), London.

Bellin, N., van Wesemael, B., Meerkerk, A., Vanecker, V. and Barberá, G.G. (in press): The decay of soil conservation structures, a case study from south east Spain. *Catena.*

Calatrava, J. and González, M. C. (2008): Adopción de prácticas de conservación de suelos en la Comarca del Guadalentín (Murcia), resultados de una encuesta a agricultores. Documento de trabajo. Universidad Politécnica de Cartagena.

Calatrava, J., Franco, A. and González, M.C. (2007): Analysis of the adoption of soil conservation practices in olive groves, the case of mountainous areas in Southern Spain. *Spanish Journal of Agricultural Research* 5(3), pp. 249-258.

CARM (2007): Programa de Desarrollo Rural de la Región de Murcia 2007-2013. Consejería de Agricultura y Agua. Comunidad Autónoma de la Región de Murcia, Murcia.

Faz, A., Arnaldos, R., Carrasco, L. and Marín, P. (2001): Study of some quality parameters for different types of soil in SE Spain in relation to their management as a basis for and planning. *Advances in Ecological Sciences* 10, pp. 301-310.

Fernández-Gálvez, J. and Barahona, E. (2005): Changes in soil water retention due to soil kneading. *Agricultural Water Management* 76, pp. 53-61.

Franco, A. and Calatrava, J. (2008): Adoption and diffusion of no tillage practices in Southern Spain olive groves. XII International Congress of the European Association of Agricultural Economists (EAAE), Ghent (Belgium), 26-29 August.

Franco, J.A. (2009): Análisis Económico de la Erosión de Suelos Agrarios, el Caso del Olivar del Alto Genil Granadino. Unpublished Doctoral Dissertation, Department of Agricultural Economics, Sociology and Policy. University of Cordoba, Spain.

García-Pintado, J., Martínez-Mena, M., Barberá, G.G., Albaladejo, J. and Castillo, V.M. (2007): Anthropogenic nutrient sources and loads from a Mediterranean catchment into a coastal lagoon: Mar Menor, Spain. *Science of the Total Environment* 373, pp. 220-239.

García-Ruiz, J.M., Lasanta, T. and Alberto, F. (1997): Soil erosion by piping in irrigated fields *Geomorphology* 20, pp. 269-278.

Gómez, J.A., Giráldez, J.V., Pastor, M. and Fereres, E. (1999): Effects of tillage method on soil physical properties, infiltration and yield in an olive orchard. *Soil and Tillage Research* 52, pp. 167-175.

González-Vázquez, J.C., Grande, J.A., Barragán, F.J., Ocaña, J.A. and de la Torre, M.L. (2005): Nitrate accumulation and other components of the groundwater in relation to cropping system in an aquifer in Southwestern Spain. *Water Resources Management* 19, pp. 1-22.

Govers, G., Van Oost, K. and Poesen, J. (2006): Responses of a semi-arid landscape to human disturbance: A simulation study of the interaction between rock fragment cover, soil erosion and land use change. *Geoderma* 133, pp. 19-31.

Hein, L. (2007): Assessing the cost of land degradation, a case study for the Puentes catchment, southeast Spain. *Land Degradation and Development* 18, pp. 631-642.

Izcara-Palacios, S.P. (2000). La directiva de nitratos en España (el ejemplo del Campo de Dalías, Almería). *Revista Española de Estudios Agrosociales y Pesqueros* 186, pp. 203-226.

Cummings, J.J., Gómez, C., Peco, A. and Sumpsi, J.M. (2002): Report on the results of in-depth qualitative interviews with local, regional and national policy-makers on the implementation and effects of past policies in the Guadalentín Target Area. Deliverable 19 of the Medaction (Policies for land use to combat desertification) Project. Madrid.

Lesschen, J.P., Kok, K., Verburg, P.H. and Cammeraat, L.H. (2007): Identification of vulnerable areas for gully erosion under different scenarios of land abandonment in Southeast Spain. *Catena* 71, pp. 110-121.

Lícer, C., Moreno, J.L. and de las Heras, J. (2007): Ecotypes in south-central Spain rivers: The interaction among land use and pollution. *WIT Transactions on Ecology and Environment* 103, pp. 241-251.

López, M.V., Moret, D., Gracia, R. and Arrúe, J.L. (2003): Tillage effects on barley residue cover during fallow in semiarid Aragon. *Soil and Tillage Research* 72, pp. 53-64.

Martínez-Raya, A., Durán, V.H. and Francia, J.R. (2006): Soil erosion and runoff response to plant-cover strips on semiarid slopes (SE Spain). *Land Degradation and Development* 17, pp. 1-11.

Martínez-Fernández, J. and Esteve, M.A. (2005): A critical view of the desertification debate in south-eastern Spain. *Land Degradation and Development* 16, pp. 529-539.

Martínez-Mena, M., López, J., Almagro, M., Boix-Fayos, C. and Albaladejo, J. (2008): Effect of water erosion and cultivation on the soil carbon stock in a semiarid area of South-East Spain. *Soil and Tillage Research* 99, pp. 119-129.

Milgroom, J., Soriano, M.A., Garrido, J.M., Gómez, J.A. and Fereres, E. (2007): The influence of a shift from conventional to organic olive farming on soil management and erosion risk in southern Spain. *Renewable Agriculture and Food Systems* 22, pp. 1-10.

Oostwoud Wijdenes, D.J., Poesen, J., Vandekerckhove, L. and Ghesquiere, M. (2000): Spatial distribution of gully head activity and sediment supply along an ephemeral channel in a Mediterranean environment. *Catena* 39, pp. 147-167.

Ordóñez, R., González, P., Giráldez, J.V. and Perea, F. (2007): Soil properties and crop yields after 21 years of direct drilling trials in southern Spain. *Soil and Tillage Research* 94, pp. 47-54.

Pérez-Sirvent, C., Martínez-Sánchez, M.J., Vidal, J. and Sánchez, A. (2003): The role of low-quality irrigation water in the desertification of semi-arid zones in Murcia, SE Spain. *Geoderma* 113, pp. 109-125.

Rodríguez-Lizana, A., Ordóñez, R., Espejo-Pérez, A.J. and González, P. (2007): Plant cover and control of diffuse pollution from P in olive groves, use of plant cover for control of agricultural nonpoint source pollution from soluble P in ecological olive groves. *Water, Air, and Soil Pollution* 181, pp. 17-34.

Rojo, L. (2004): Guidelines for adaptation of the present policy framework to include long term changes, in order to anticipate policy schemes for mitigation of desertification in the long term. Deliverable 3.3c of the Desertlinks Project. Madrid.

Romero, A., Marín, P., Sánchez, A., Belmonte, F. and Faulkner, H. (2007): The causes of piping in a set of abandoned agricultural terraces in southeast Spain. *Catena* 69, pp. 282-293.

Van Wesemael, B., Rambaud, X., Poesen, J., Muligan, M., Cammeraat, E. and Stevens, A. (2006): Spatial patterns of land degradation and their impacts on the water balance of rainfed treecrops: A case study in South East Spain. *Geoderma* 133, pp. 43-56.

Varela-Ortega, C., Sumpsi, J.M. and Blanco, M. (2002): Water availability in the Mediterranean region. In: Brouwer, F. and van der Straaten, J. (eds.): Nature and Agriculture Policy in the European Union. International Library of Ecological Economics. Edward Elgar, Cheltenham, UK.

Villar-Mir, J.M., Villar-Mir, P., Stockle, C.O., Ferrer, F. and Aran, M. (2002): On-farm monitoring of soil nitrate-nitrogen in irrigated cornfields in the Ebro Valley (northeast Spain) *Agronomy Journal* 94, pp. 373-380.

Whitby, M., Saunders, C. and Ray, C. (1998): The full cost of stewardship policies. In: Dabbert, S., Dubgaard, A., Slangen L. and Whitby, M. (eds.): The Economics of Landscape and Wildlife Conservation. CAB International, Wallingford, pp. 97-112.

Annexes

Annex 1

List of interviews (Questionnaire 2)

Interview Date	Interviewee (affiliation/position)	Type of interview
13/05/2008	Individual farmer	face-to-face
13/05/2008	Part-time non-professional farmer	telephone
15/05/2008	Individual farmer	face-to-face
19/05/2008	Individual farmer	face-to-face
27/05/2008	Individual farmer	face-to-face
27/06/2008	Individual farmer	face-to-face
03/07/2008	Individual farmer	face-to-face
06/07/2008	private enterprise, manager of the farm	telephone

List of interviews (Questionnaire 3 and 4)

Interview Date	Interviewee (affiliation/position)	Type of interview
21/04/2008	Chief of the Service for Rural Development, Regional Government of the Murcia Region.	face-to-face
21/04/2008	Regional Secretary for Murcia of the Union of Small Farmers (UPA).	face-to-face
28/04/2008	Director of the Integrated Centre for Agricultural Formation and Experimentation (CIFEA) in Lorca (case study area), Regional Government of the Murcia Region.	face-to-face
29/04/2008	Associate Professor, expert on soil conservation issues, University of Murcia.	face-to-face
05/05/2008	Technical officer from the Local Agricultural Office (OCA) at Lorca (case study area), Regional Government of the Murcia Region.	face-to-face
06/05/2008	Technical officer from the Local Agricultural Office (OCA) at Lorca (case study area), Regional Government of the Murcia Region.	face-to-face
07/05/2008	Technical advisor of the COATO cooperative in Totana (case study area)	face-to-face
21/05/2008	Town councillor for agriculture of the City of Totana (case study area).	face-to-face
21/05/2008	President of The Water Users Association of Totana (case Study area).	face-to-face

19/05/2008	Associate Professor in agricultural economics, Polytechnic University of Cartagena (UPCT).	face-to-face
27/05/2008	Director of the Local Agricultural Office (OCA) at Alhama de Murcia (case study area), Regional Government of the Murcia Region.	face-to-face
29/05/2008	Technical officer from the Local Agricultural Office (OCA) at Alhama de Murcia (case study area), Regional Government of the Murcia Region.	face-to-face
02/06/2008	Scientific Researcher in agricultural economics, CEBAS-CSIC, Murcia	face-to-face
02/07/2008	Representative of the ecologist NGO ANSE.	face-to-face

Annex 2

Glossary of policy measures

English title of policy measure (law, regulation, initiative)	**National title of policy measure**
Royal Decree 261/1996 on the protection of water against nitrate pollution from agricultural sources	Real Decreto 261/1996, de 16 de febrero, sobre protección de las aguas contra la contaminación producida por los nitratos procedentes de fuentes agrarias.
Law 62/2003 that modifies the new text of the Water Law (Royal Decree 1/2001).	Ley 62/2003, de 30 de diciembre, de medidas fiscales, administrativas y del orden social que modifica el texto refundido de la Ley de Aguas, aprobado por Real Decreto Legislativo 1/2001, de 20 de julio.
National Action Program to fight against desertification	Programa de Acción Nacional de Lucha contra la Desertificación
Conservation of Wild Birds Directive (79/409/EEC)	Directiva 79/409/CEE del Consejo, de 2 de abril de 1979, relativa a la conservación de las aves silvestres
Flora-Fauna-Habitat Directive (92/43/EEC)	Directiva 92/43/CEE del Consejo, de 21 de mayo de 1992, relativa a la conservación de los hábitats naturales y de la fauna y flora silvestres Ley 4/89 de Conservación de los Espacios Naturales y de la Flora y la Fauna Silvestres Ley 4/92 de 30 de Julio, de Ordenación y Protección del Territorio de la Región de Murcia
Water Framework Directive	Directiva Marco del Agua
Agri-environmental schemes	Programas Agroambientales
Direct Support Scheme	Pago Unico
European Soil Framework Directive	Directiva Marco de Suelos

Annex 3

Short description of policies with relevance for soil conservation

Agricultural Infrastructure

The responsibility for the planning, design and management of agricultural infrastructures is shared among different national and regional authorities, and farmers themselves in some cases. Rural roads are usually responsibility of the Regional Government in the case of one-province regions such as Murcia, and of the Province authority (Diputación Provincial) in the case of multi-provinces regions such as Andalusia. However, there are also rural roads that are built and managed by Water Users' Associations or municipalities. Rural roads within farms are built by farmers. In the case of irrigation infrastructures, there are areas where they are privately-developed. In large irrigation districts, the National Ministry of Agriculture, or eventually other National or Regional administrations, co-finances the development of modernisation of irrigation perimeters, but these are managed by the Water Users' Associations.

Regulation of rural land use

The transformation of land from non agricultural uses to agricultural ones is regulated by the national Law 43/2003 of "Montes" (loose translation of Monte is "non-agricultural land" or forest, rangelands and grasslands). One of the main problems is that this law does not provide good methods to distinguish between agricultural and non-agricultural lands, especially on fuzzy situations like agricultural land that was abandoned very long ago. Enforcement of this law is usually carried out by the Nature Protection Service of Guardia Civil (a national police body for rural areas) and the Environment Wards of the Regional Governments. It is common, nonetheless, that complaints filed by field agents suffer very slow processing in the office. The transformation from agricultural to industrial or urban land is regulated by the municipalities.

Waste Regulation

The regulation of sewage sludge is regulated by the Decree 1310/1990 that transposes the European Directive 86/278/CEE.

The Spanish Law number 10/1998 transposes the European Directive 91/156/CEE that regulates the disposal of agricultural wastes. However, for non-toxic agricultural wastes that are used in the farms the main regulation is the Royal Decree 261/1996, which transposes the European Nitrates Directive.

The burning of stubbles is regulated at the regional level. Farmers must ask for a permit to proceed and there is full prohibition during periods of high risk of forest fires. Apart from that, the prohibition of burning stubbles is included in the Good Farming Practices that are necessary to participate in the RDP and accompanying measures (Regulation 2078/92 applied by the national legislative act Royal Decree 4/2001). As we will later comment, the overall responsibility for its implementation, monitoring and sanctioning rests within the Regional Governments. Regarding the disposal of agricultural plastics, it is basically regulated at the municipal level.

Water Regulation

Regarding the Nitrates Directive, the national Royal Decree 261/1996, that transposes the European Nitrates Directive 91/676/CEE, established that it is the responsibility of the Regional Governments to establish a "Good Agricultural Practices" code that is compulsory in vulnerable areas and voluntary in non-vulnerable areas. The Guadalentín basin is not considered as a vulnerable area according to the criteria established in the Royal Decree 261/1996. However, the general provisions of Cross Compliance in regulation 1782/2003 establish that any farmer receiving direct payments should observe the statutory management requirements referred to in Annex III, which includes the Nitrates Directive.

Therefore, farmers in the area that are receiving direct payments (most of the dry land areas and a little of the irrigated ones) are being monitored by the Regional Agricultural Authority to check whether they are complying with practices in the regional "Good Agricultural Practices" code.

The implementation of the Water Framework Directive is the responsibility of the River Basin Authorities that depend on the National Ministry of the Environment. In the Segura river basin, where the Guadalentín basin is located, the implementation process is quite advanced. The assessment of the environmental vulnerability of water bodies and its risk of compliance with the good ecological status of water, as well as the assessment of the costs of water services and the economic value of water were completed in 2006. The implementation process is currently in the phase of establishing the set of measures to ensure the good ecological status of water (the deadline is the end of 2008).

Agri-Environment Incentive Policies

Agri-Environmental Measures (AEM) are an element of the RDP 2007-2013 (Regulation 1698/2005/EC applied at the regional level by the Rural Development Plan 2007-2013 of the Murcia Region). AEM in the previous period 2000-2006 were designed by the National Government, but the new ones are designed by the regional governments themselves. In the Murcia Region, there is a specific AEM for soil erosion.

The overall responsibility for the implementation of the Agri-Environmental measures rests with the Regional Government. The administrative implementation and monitoring is performed through its local district agricultural extension agencies (OCAs). The monitoring process includes administrative checks of all applications of payments for the AEM via the Integrated Agricultural Control System (IACS) and on-the-farm checks of 5 % of all farms receiving AEM payments based on a specific risk analysis. Infringement of requirements leads to rejection of the application, reduction of payments, or the (partial) recall of the payments.

Single Payment Scheme/Cross Compliance

Cross compliance rules for soil protection in Spain are determined in the Royal Decree 2352/2004 that applies Annex IV of Regulation 1782/2003 (Good Agricultural and Environmental Condition GAEC). The following cross compliance rules affect directly relevant soil conservation issues: building and maintaining terraces; maintaining vegetation covers; adapting ploughing to slope (no ploughing in slopes greater than 15 % except if terraces exist, conservation tillage is used or a total vegetation cover of soil is kept); and all crops should be planted as soon as possible in order to avoid soil exposure to eroding factors.

Regional governments have participated in establishing the practices or requirements in the cross compliance rules. Although they can establish additional requirements, in all cases the regional laws applying the corresponding Royal Decrees just include the same requirements as the National legislation. That is, as is the case with the soil erosion AEM, cross compliance rules for soil erosion control are not locally adapted.

As with the AEM, the Regional Governments are responsible for the implementation of Cross Compliance with respect to soil protection. The monitoring process includes administrative checks of all applications for direct payments via the Integrated Agricultural Control System (IACS), systematic on-the-farm checks of 1 % of all farms receiving direct payments, and cross checks. Regarding sanctions, those detected cases of infringement lead to a reduction in direct payments up to 100 %, depending on the severity and reiteration of the infringement.

Good Agricultural Practice Measures

Good Farming Practices are necessary to participate in RDP (Regulation 1257/99 applied by Annex I of Royal Decree 4/2001 and Royal Decree 613/2001). Of special importance in the area are the programmes that finance improvements in farm structures (e.g. planting of new varieties, modernisation of farm infrastructures, improvement of animal welfare conditions, etc.). Regarding soil conservation, only the obligation to plough following contour lines is considered and some recommendations are made regarding machinery use and crop rotations. Guidance to farmers is established through technical publications and assistance from the local extension services (OCAs).

Other agricultural and environmental policies

Spain is the country of the EU with the largest protected area in absolute terms for both the Birds 74/409/CEE (Special Protection Areas, SPA) and Habitat 92/43/CEE (Special Areas of Conservation, SAC) Directives. It has the second largest protected area in relative terms of spaces protected by the Birds Directive and the third one under the Habitats Directive. Consequently, the area of Guadalentín has a large area of protected spaces under both directives.

In the Region of Murcia there are six SPAs that are totally or partially within the Guadalentín basin, five of them are in the ranges surrounding the valley or flat uplands, while one is on the naturally saline soils of the valley bottom. There are also eight SACs, five of them not overlapping SPAs. These are located on mid-altitude ranges, totalling more than 60,000 ha within the basin. On the province of Almería there are only two SACs and one SPA effectively protecting most of the part of the basin located on the province. The SPA completely overlaps to one of the SACs.

On conclusion, the Nature 2000 network in the Guadalentín basin is quite large and, although it covers basically mountain and highlands, it also covers large extensions of marginal agricultural areas of soil conservation concern.

European Commission

EUR 24131 EN/1 – Joint Research Centre – Institute for Prospective Technological Studies
Title: Case Study – Spain, Sustainable Agriculture and Soil Conservation (SoCo Project)
Author(s): Javier Calatrava Leyva, Gonzalo González Barberá, Víctor Castillo

Luxembourg: Office for Official Publications of the European Communities
2009
EUR – Scientific and Technical Research series – ISSN 1018-5593
ISBN 978-92-79-14628-2
DOI 10.2791/35621

Abstract

This Technical Note 'Case Study – Spain' is part of a series of case studies within the 'Sustainable Agriculture and Soil Conservation' (SoCo) project. Ten case studies were carried out in Belgium, Bulgaria, the Czech Republic, Denmark, France, Germany, Greece, Italy, Spain and the United Kingdom between spring and summer 2008. The selection of case study areas was designed to capture differences in soil degradation processes, soil types, climatic conditions, farm structures and farming practices, institutional settings and policy priorities. A harmonised methodological approach was pursued in order to gather insights from a range of contrasting conditions over a geographically diverse area. The case studies were carried out by local experts to reflect the specificities of the selected case studies.

The mission of the Joint Research Centre is to provide customer-driven scientific and technical support for the conception, development, implementation and monitoring of European Union policies. As a service of the European Commission, the Joint Research Centre functions as a reference centre of science and technology for the Union. Close to the policy-making process, it serves the common interest of the Member States, while being independent of special interests, whether private or national.

LF-NA-24131-EN-C

ISBN 978-92-79-14628-2